SEED-TIME.

# THE
# PRINCIPLES AND PRACTICE
# OF
# AGRICULTURE,
SYSTEMATICALLY EXPLAINED;

IN TWO VOLUMES:

Being a Treatiſe compiled for the Fourth Edition of
The ENCYCLOPÆDIA BRITANNICA,

AND REVISED AND ENLARGED BY

ROBERT FORSYTH, ESQ.

VOL. I.

EDINBURGH:
PRINTED BY THE PROPRIETOR, A. BELL.
AND SOLD BY ARCH. CONSTABLE & CO. EDINBURGH;
AND VERNOR & HOOD, LONDON.
1804.

TO

THE RIGHT HONOURABLE

LORD SHEFFIELD,

PRESIDENT,

AND THE OTHER MEMBERS

OF

THE BOARD OF AGRICULTURE,

THIS WORK IS RESPECTFULLY DEDICATED,

THE PROPRIETOR.

PREFACE.

IT may here ſeem neceſſary to give ſome account of the origin and progreſs of the work now preſented to the public.

In the third edition of the Encyclopædia Britannica, which has been received by the world with ſuch approbation, as to obtain a degree of currency, which is without example in works of ſuch magnitude, the art of Agriculture was diſcuſſed under the various ſeparate heads, of Agriculture, Huſbandry, Draining, Moſs, and others, ſuggeſted by the alphabetical arrangement of a dictionary of Arts and Sciences. The property of that work having at length become concentrated in an individual, he reſolved to proceed to a fourth edition, containing ſuch alterations and improvements, as the courſe of time and the progreſs of the arts had rendered neceſſary.

In the execution of this taſk, it appeared an object of importance, to concentrate, as much as poſſible, the diſcuſſion of the various branches of Science or of Art, into a ſyſtematic form, under a few diſtinct heads; inſtead of leaving their different parts and members ſcattered, as formerly, throughout eighteen or twenty volumes.

Accordingly, at the commencement of the fourth edition of the Encyclopædia Britannica, the propoſed alteration was undertaken with regard to the ſubject of Agriculture, which, from the alphabetical arrangement, neceſſarily preſented itſelf for diſcuſſion at a very early period of the work. The various branches of that art were condenſed into a ſingle treatiſe; and, although various particulars were introduced or diſcuſſed at greater length than formerly, yet by lopping off the redundancies which unavoidably occurred in the former ſcattered mode of diſcuſſion, and by adhering ſtrictly to a ſyſtematic arrangement, the whole was conſiderably abbreviated.

After the treatiſe alluded to had been compiled and printed, it occurred to the proprietor, that conſiderable numbers of perſons, to whom the peruſal of it might be productive of much advantage, would be very unlikely to become purchaſers of a literary work of ſuch magnitude and expence as the Encyclopædia Britannica. As it is of the utmoſt importance, however, to the public, to give all poſſible currency to literary works upon an art which is of ſuch extenſive and eſſential utility to mankind, a reſolution was adopted to introduce to the world, as a ſeparate publication, the treatiſe upon Agriculture, which had been prepared for the fourth edition of the great work above mentioned. At the ſame time it was thought, that before carrying this reſolution into effect, it might be proper to reviſe the whole treatiſe, and to make ſuch additions or alterations as ſhould ſeem requiſite for its farther improvement. This taſk has accordingly been undertaken, and the reſult is preſented to the public. The alterations which have been made conſiderably exceed, both in number and extent, what was originally intended; ſo that a great part of the treatiſe has changed its character, although the former arrangement has, upon the whole, been adhered to: In particular, the hiſtory of the art has been much enlarged; advantage has been taken of recent publications, eſpecially of thoſe which the Board of Agriculture ſuggeſted or brought forward, to explain the principles upon which the rotation of crops and the culture of graſſes ought to be conducted; various other branches of the ſubject have, in like manner, been enlarged or altered; and ſome ſubjects of agricultural curioſity in the practice of foreign nations have been introduced, which, it is hoped, will prove not unacceptable to the claſs of readers for whoſe uſe this work is intended.

Throughout the treatiſe, practical utility is the object kept in view; and the notions of ingenious and ſpeculative men, which have a tendency to miſlead into raſh projects perſons engaged or engaging in agriculture, are carefully avoided. No more of theory is introduced than ſeemed abſolutely neceſſary to exhibit a view of thoſe general principles, which long experience in the art has dictated to men of ſound judgment and correct obſervation.

In the details given, conciſeneſs, as far as conſiſtent with perſpicuity, has been chiefly kept in view; but by adhering ſtrictly to a ſyſtematic arrangement, a very great variety of ſubjects will be found introduced and diſcuſſed.

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A Vignette of Harveſt, and the Plates Nº VII. X. XII. XIV. and XX. to be inſerted in Vol. II.: the remainder in Vol. I.

SYSTEM

OF

AGRICULTURE.

INTRODUCTION.

Definition.

AGRICULTURE in general, or in the abſtract, may be defined to be, The art of making the earth to produce in large quantities, and in the greateſt perfection of which their nature is capable, thoſe vegetables which are neceſſary to the ſubſiſtence, or uſeful for the accommodation, of mankind. Agriculture differs from gardening in this reſpect, that the gardener is chiefly occupied in rearing ſmall quantities of the nicer and more delicate vegetables, which are rather valued as objects of luxury than as articles of food; whereas the agriculturiſt labours upon a larger ſcale, with a view to ſupply himſelf and his countrymen with the neceſſaries of life.

Differs from gardening.

Is a ſeparate art.

In civilized ſocieties, agriculture, or the cultivation of the ſoil, becomes a ſeparate buſineſs or employment; and agriculturiſts, or the perſons engaged in agriculture, receive the appellation of *farmers* or *huſbandmen*.

Includes the rearing of cattle.

To enable the agriculturiſt or huſbandman to conduct his buſineſs with ſucceſs, it is neceſſary that he

Nature of the Art.

ſhould not confine his attention to the mere cultivation of the ſoil, or the rearing of vegetables. The vegetables which are capable of affording a comfortable ſubſiſtence to the human conſtitution are few in number; and it has been found by experience, that they cannot be profitably ſown and reproduced year after year upon the ſame ſpot of ground. Hence it becomes neceſſary at times to rear upon it graſſes or other plants which are unfit for affording nouriſhment to man. But although men cannot eat graſs, they may, nevertheleſs, contrive to obtain ſubſiſtence from it in an indirect manner. They may give it to cattle, whoſe ordinary and natural food it is; and having thus, as it were, converted the graſs into the fleſh of animals, they can devour theſe animals; and in this way, obtain a richer and more ſtimulating food than any vegetable production can poſſibly afford. It is therefore a part of the buſineſs of the huſbandman to rear and to feed thoſe animals which are uſed as food in the ſociety of which he is a member, that he may be enabled at all times to derive profit from the portion of territory that he cultivates. It is alſo neceſſary towards conducting his operations with ſucceſs, that he ſhould rear and feed other animals, not as a ſource of human ſubſiſtence, but for the ſake of the ſervices which they are capable of affording; for it has pleaſed the beneficent Contriver of this world, to place upon it beings of a ſubordinate nature, capable of aſſiſting mankind in their labours, without being degraded by the ſtate of ſervitude in which they are placed. To the cultivators of the ſoil, theſe animals, from their ſtrength and patience of labour, are particularly uſeful, and even abſolutely neceſſary in our cold and barren climates.

They muſt therefore be fed and lodged with the greateſt care.

Importance of the Art.

Hence, the employment of the huſbandman is of an extenſive nature, requiring much foreſight, and a conſiderable knowledge of the relations that ſubſiſt between the moſt important objects in nature—the ſoil, the ſeaſons, the animals, and the plants, ſo far as they are connected with the ſubſiſtence of mankind. It is by bringing to perfection this art that man becomes truly the lord of the univerſe. He ſubdues by his operations every part of the ſurface of the earth, and acquires over the animals which inhabit it, a ſolid right of dominion or of property, in conſequence of having reared, and afforded them ſubſiſtence by his ſkill and his labour. He uſes them indeed as food; but before he can do ſo, he muſt firſt beſtow upon them ſubſiſtence, attend to their multiplication, and to their health and welfare. As they poſſeſs no foreſight, the purpoſe to which they are deſtined is to them no evil.

It is only in proportion to the degree in which this important art of agriculture has flouriſhed, that nations have been, or ever can be, permanently proſperous. Every improvement that is made in it is a moral benefit conferred upon mankind; for, by increaſing the quantity of human food, or facilitating the production of it, one of two things muſt always happen: Either the number of our ſpecies will be increaſed, that is to ſay, a greater multitude of rational and intelligent beings will exiſt in the creation; or a greater number of thoſe who already exiſt, will find leiſure for the improvement of their intellectual characters, by ſtudying and carrying to perfection the ſciences and arts. Thus, the

Hiſtory. ſtrength of nations is increaſed in proportion to the degree in which their ſoil is ſkilfully cultivated, and their independence is ſecured by finding upon the ſpot *which they inhabit all that is neceſſary for their ſubſiſtence.*

tages to thoſe who practiſe it.

It is a fortunate circumſtance, that the art of the *huſbandman, which is the foundation of all others, and* at all times *indiſpenſable to human exiſtence, is in every reſpect* conducive to the welfare of thoſe engaged in it. The practice of it beſtows health upon the body; and by the variety of occupations which it affords, it alſo beſtows a conſiderable degree of reflection upon the minds of the loweſt perſons occupied in it; while, at the ſame time, it prevents their acquiring that ſpirit of artifice and of cunning, which in all countries is apt to degrade the character of thoſe engaged in the inferior branches of commercial employment. Nor does it fail, in all ranks and conditions of life, to produce a more candid and liberal character than any other employment. No Britiſh huſbandman has ever refuſed, or even heſitated to allow to be communicated to the public every branch of his art, and every improvement which he and his forefathers may have made in it; whereas, in all the branches of manufacture or of commerce, every tranſaction, as far as poſſible, is covered with a myſterious veil of ſecrecy, and every improvement is concealed by its inventor, and ſometimes undoubtedly periſhes with him.

Hiſtory. No branch of hiſtory is more inſtructive, nor conſequently more important, than that which explains the progreſs of the human mind in the diſcovery and improvement of the uſeful arts. As the art of agriculture, in point of utility, ranks above all others, a detail of the

efforts

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efforts by which ingenious men have brought it to its preſent degree of perfection, would undoubtedly prove extremely intereſting. It has hitherto, however, been one of the misfortunes of mankind, that, in conſequence of a falſe taſte, they have beſtowed more attention and applauſe upon great talents or ingenuity, when exerted in the arts of deſtruction, than when employed in deviſing the means of giving plenty and felicity to nations. The writings of hiſtorians and poets are filled with the actions of men, who, under the influence of an inſatiable luſt of dominion, have waſted cities and provinces, and have defaced the faireſt monuments of human genius and induſtry; while the beneficent enterprizes and efforts of thoſe men are neglected or forgotten, who invented the inſtruments of agriculture, who ſelected or imported into their country the plants moſt worthy of cultivation, or who drained moraſſes, gave fertility to barren waſtes, and pointed out the beſt modes of preſerving and augmenting the productive powers of the ſoil.

Mankind have ſuffered ſeverely, in conſequence of their abſurd admiration of ſucceſsful ambition, and the applauſe which they beſtow upon it. By this applauſe they in every age tempt reſtleſs individuals to lay ſchemes for their deſtruction, and to glory in the debaſement and miſery which they bring upon large portions of the human race. It were well, therefore, if the friends of humanity could contrive to do away this falſe taſte, by calling from obſcurity, and beſtowing [illegible]tion of renown, upon the true friends of mankind, whoſe labours have in ancient or modern times been directed towards promoting the beſt intereſts of mankind by the improvement of this moſt important

Hiſtory. of all arts. The materials, however, for a hiſtory of agriculture are few, and it is inconſiſtent with our plan to give more than the moſt general outline of what is known concerning it in paſt ages.

The hiſtory of agriculture is equivalent to the hiſtory of civilization and of arts. Men who paſs their days in the unſettled ſtate of hunters and ſhepherds, muſt always be few in number. As their wants are not many, their means of ſupplying them, that is, their arts, will be proportionably unimportant. It is only when the increaſe of their numbers has compelled them to have recourſe to the cultivation of particular plants, and when the reſult of an improved agriculture has in its turn provided ſubſiſtence for multitudes of men in a ſtationary or ſettled ſtate, that human ingenuity is rouſed to the diſcovery of the ſecrets of nature, by ſearching after modes of gratifying new and more refined wants than were formerly known. Accordingly, we find in every country, and in every age of the hiſtory of mankind, that agriculture has been the baſis of civilization, and that they have gone hand in hand in improvement.

Eaſtern agriculture. The great civilized nations which in ancient times occupied the eaſt were chiefly three: towards the riſing ſun was the great empire of China; on the ſouth was India; and on the weſt was Perſia, which in its progreſs ſtill further weſtward, came to include the country of the Aſſyrians, and the territories which bound the eaſtern ſhores of the Mediterranean ſea, Leſſer Aſia, Syria, and Egypt. In all theſe countries letters and arts have exiſted from very remote periods, and along with them, as their foundation and ſupport, agriculture has flouriſhed; and, which is of more importance,

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portance, the perſons engaged in it have been held in very great eſtimation. On the contrary, the Tartars, who have in all ages occupied the northern regions of Aſia, together with the great, elevated, and deſert tract of country between Perſia and China, have always exiſted in a paſtoral, and conſequently in a barbarous ſtate, equally ſtrangers to agriculture and to the arts which it produces.

The civilization of the Chineſe empire appears to have exiſted from the remoteſt antiquity; and long experience has taught that people the great importance of agriculture, and the eſtimation in which it ought to be held. Accordingly, by a fundamental part of their policy, it is diſtinguiſhed and encouraged by the government beyond all other arts or employments. To render it honourable, the emperor annually, at the beginning of the ſpring, which is the commencement of their year, goes to a field in perſon, in a common cart or waggon, painted green, and in preſence of the princes of the blood royal, of the officers of ſtate, and firſt mandarins of the empire, holds the plough for a time. The ceremony is extremely ſolemn, and the emperor offers up prayers for a plentiful crop to his people. On the ſame day, a ſimilar ceremony is performed by the governor or chief mandarin in every province of that great empire.

With a ſimilar view of rendering it honourable, and calling the attention of all orders of men to the importance and value of agriculture, it was a cuſtom the ancient Perſians, that once a-month their king ſat down to table with a party of practical huſbandmen, or perſons engaged in the ordinary labours of agriture. This people had a regular prieſthood for in-

Hiſtory. *ſtructing the people in their religious duties*; and it is not a little remarkable that agriculture was repreſented by them as the moſt acceptable ſervice which a devotee could perform in the ſight of their ſupreme deity, the ſun or element of fire. The *ſaint* among them was obliged to work out his ſalvation by the practice of all the labours of agriculture; and it was a maxim, that he who cultivates and ſows the ground with care and diligence, acquires a greater chance of paradiſe than he could have gained by the repetition of ten thouſand prayers.

Hindoſtan, at the time of its invaſion by Alexander of Macedon, appears to have been nearly in the ſame ſtate in which we at preſent find it. Agriculture was carefully attended to, and along with it the uſeful arts flouriſhed, riches abounded, and the people were numerous, humane, and happy, though unfortunately enfeebled by a degrading ſuperſtition, which by preventing the free exertion of their faculties, renders them an eaſy prey to every invader. Even in their ſuperſtition, however, their reſpect for agriculture appears. Hence aroſe the divine honours long paid by them to Bacchus, as the firſt teacher of the art of cultivating the vine.

From a ſimilarity of ſuperſtitions and of manners, it appears extremely probable that ſome cloſe connexion ſubſiſted at a remote period between the Hindoos and the ancient Egyptians. The banks of the Ganges and of the Nile are fertilized in the ſame manner, and upon both, the art of agriculture is of an extremely remote antiquity. The ancient Egyptians, like the Hindoos, raiſed vaſt quantities of corn; and ſo ſenſible were they of the importance of the art which enabled them to do ſo, that they

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they worſhipped as a god, its real or reputed inventor, under the appellation of Oſiris. They regarded Iſis, their ſecond deity, as the diſcoverer of the uſe of wheat and barley, and as the firſt who, having gathered the ſeeds of theſe grains in the woods, ſowed them on prepared land, and reaped a crop thus procured by art.

In theſe eaſtern nations the moſt valuable practices in agriculture were well known. The uſe of the plough was known. Hollow draining was ſo well underſtood, together with the purpoſes to which it may be applied, that the modern Perſians are in ſome places ſaid to find water in their fields, conveyed in channels, of which they know not the courſe, but which have been placed there in former times by a more induſtrious and intelligent people. Artificial canals for watering the ſoil, and even for conveying its produce to diſtant places, appear to have been long uſed in the eaſt. Mills were uſed in India of a very ſimple and ingenious conſtruction for grinding grain. No threſhing machine, however, appears to have been invented; and to this day, over all Aſia, the corn is trodden out from the ear by the feet of cattle.

The Phœnicians, who inhabited the eaſtern coaſt of the Mediterranean, and are ſo frequently mentioned in the ſacred Scriptures by the appellation of Philiſtines, (i. e. Paleſtines, or inhabitants of Paleſtine,) appear to have made conſiderable progreſs in agriculture. Being a maritime people, they carried their civilization and arts to various iſlands, and to ſeveral countries along the ſhores of the Mediterranean. Carthage was one of their colonies; and we know that, as early as the days of Herodotus, the part of Africa adjoining to that city, and which formed its territory to the weſt-

ward,

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ward, was inhabited by an agricultural people. As the Greeks derived the firſt rudiments of their literature from the Phœnicians, there can be little doubt of their having obtained their knowledge of agriculture from the ſame quarter.

Agriculture of the Greeks.

Notwithſtanding their conſtant wars, the ſituation of the Greeks appears upon the whole to have been favourable to agriculture. They were divided into a great variety of petty ſtates, in which the territory was chiefly held by ſmall proprietors who cultivated their own lands. The great population of the country, waſted as it ſo frequently was by inteſtine wars, could only be ſupported by conſiderable ſkill, or at leaſt by great induſtry in agriculture.

Heſiod was the firſt known to us among the Greeks who wrote on this intereſting ſubject. According to the cuſtom of the Oriental authors, he wrote in poetry, and embelliſhed his poem with luxuriant deſcription and ſublime imagery. He calls his poem *Works and Days*, becauſe agriculture requires the exact obſervation of times and ſeaſons.

Xenophon, in his Oeconomics, has remarked, that agriculture is the nurſing mother of the arts. For, ſays he, "where agriculture ſucceeds proſperouſly, there the arts thrive; but where the earth neceſſarily lies uncultivated, there the other arts are deſtroyed."

Other eminent Greek writers upon agriculture were, Democritus of Abdera, Socraticus, Archytas Tarentinus, Ariſtotle, and Theophraſtus, from whom the art received conſiderable improvements.

Of the Romans.

The ſtate of agriculture among the ancient Romans merits a very particular degree of attention, on account of its influence upon the political deſtiny of that ſingular people. Hiſtories of Rome and of the Romans are

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in the hands of all perſons, and their military achievements, as well as civil diſſenſions, have been tranſmitted to us with minute care and accuracy by various writers. It is underſtood by few, however, that the Romans were only conquerors becauſe they were cultivators of the ſoil, and that their love of war aroſe from their attachment to agriculture, and the independence and felicity which is enjoyed in that mode of life.

At the period when the foundation of Rome was laid, Italy appears to have been divided, as in later times, into a great multitude of petty ſtates, deſtitute of any common bond of union. From the ſimilarity of language, of inſtitutions, and of religion, as well as from vicinity of ſituation, it appears certain that Italy muſt have been peopled by colonies from Greece. Theſe colonies had arrived after the Greeks had made ſome progreſs in civilization; becauſe we learn from hiſtory, that when Rome was founded, all the neighbouring ſtates were acquainted with agriculture, and no people that is entirely barbarous can poſſeſs this art. At the date of the foundation of Rome Italy was only partially ſettled, like the United States of America, at the preſent day. Romulus appears to have acquired the property of a ſmall diſtrict of a few miles over, upon which he reſolved to eſtabliſh a colony. With this view he invited ſettlers, by gratuitous offers of ſmall portions of land; and, as the country was under no common government, he made his eſtate an aſylum for runaway ſlaves. That he was no barbarian is evident from [illegible] adopting regulations founded upon the wiſeſt maxims of colonial policy. He granted to every individual who choſe to ſettle on his territory as much land as, when well cultivated, was accounted ſufficient to ſupport

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port a poor and frugal family (two jugera). His territory was ſoon ſtocked with ſmall proprietors. The children of theſe perſons, though bred up in frugal and laborious habits, were unable to find ſubſiſtence upon the ſmall properties belonging to their parents. The country being deſtitute of commerce and manufactures, they had no other reſource than that of emigrating in ſearch of new lands. They had no money to purchaſe ſuch lands; but, uniting into a body under the chief of their community, they attacked the weakeſt of the petty neighbouring ſtates, and forced them to cede or make over to them ſome part of their territory. Thus the dominions of the petty chieftain of the Roman ſtate were increaſed, while his young men were provided for by the ſhares which they received of the conquered lands, which were fairly and equally divided among them.

The new families which were ſettled in this way upon ſmall properties, ſpeedily caſt out another ſwarm of hardy young men, trained up in frugality and the labours of agriculture, and therefore prepared to become moſt excellent ſoldiers. The ſame neceſſity which compelled their parents to invade their neighbours, obliged this new generation alſo to reſt upon the ſucceſs of their ſwords, their whole hopes of obtaining lands, on which to make uſe of the ploughſhare. Thus war became neceſſarily the occupation of the Roman youth, that they might be enabled to paſs their old age in the cultivation of the ſoil. The territory of Rome became a nurſery of ſoldiers. Her armies were invincible, becauſe the individuals of which they were compoſed, being young men of a robuſt conſtitution, and frugal and laborious habits, urged on by want, and engaged in a conteſt for

what

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what they accounted riches and independence, ſeldom encountered their equals in fortitude and courage, and never failed to perſevere in every ſtruggle, till they were either ſucceſsful or exterminated. It is true; that no nation ever ſuffered greater or more frequent defeats than the Romans in war; and in the management of their campaigns and battles, they often committed the moſt groſs military errors: but theſe were rendered of no importance to the general hiſtory of the people, in conſequence of their agricultural policy, which enabled them at all times to renew the war by means of new ſwarms of military adventurers, the ſons of their peaſantry. Hence, alſo, they never loſt a foot of territory that they once gained; becauſe the conquering army conſiſted of young men who had no intention of returning home, but who inſtantly ſettled upon the lands which they had ſubdued. A Roman army was thus a colony of huſbandmen, who made war with the ſame views, with which the original ſettlers in North America made war upon the ſavages or native inhabitants of the country, that is, that they might ſeize, and cultivate, and inhabit their lands. The Romans, indeed, were not ſuperior in arts to their immediate neighbours; and hence, their conteſt for dominion was long and arduous, and owed its ultimate ſucceſs merely to the inſtitutions of * Romulus the founder of the ſtate, the ſpirit of which, his

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The learned reader will eaſily recollect authorities which illuſtrate [illegible] confirm what is here ſtated. Ac primus agros quos bello Romulus ceperat, diviſit viritim civibus. Cic. *de Republica*, lib. 2.

Quantum attinet ad antiquos noſtros ante bellum Punicum pendebant bina jugera, quod a Romulo primum diviſa dicebantur viritim. Varro *de Re Ruſtica*, lib. 1. cap. 10.

Tandem

Hiſtory. his ſucceſſors, whether kings or conſuls, appear (with the exception of Numa) to have well underſtood, and, for ſome ages to have correctly and zealouſly carried into effect.

By degrees, indeed, the fundamental maxims, that is to ſay, the agricultural maxims of Roman policy, were diſregarded. Like other ſtates, they at laſt engaged in war not merely to provide for their ſupernumerary youth, but from a love of national power and aggrandizement. They gave pay to their ſoldiers, and kept them long in the ſervice. They no longer divided among theſe hired troops the lands, or a large portion of the lands conquered in war, but ſet them up to ſale, or left them to be held for a tribute, which was ſpent in corrupting the populace of the capital. Still, however, the whole hiſtory of Rome, from its earlieſt to its lateſt period, exhibits proofs that the labours of agriculture, even when unattended by riches, were held in higher eſtimation than they have ever been by any other European nation. The religion of the ſtate connected itſelf in a peculiar manner with this art, and impreſſed upon it a great degree of reſpectability. The people were taught to believe, that the † ſupreme divinity was the firſt who inſtructed

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Tandem pro multis vix jugera bina dabantur
Vulneribus. JUVENAL, *Sat.* 14. lib. 5.

Multis legionibus contigit bellum feliciter tranſigere, et ad glorioſam agriculturæ requiem primo tyrocinii gradu pervenire, cum ſignis et aquila et primis ordinibus et tribunis deducebantur. HYGINUS.

† Ante Jovem nulli ſubigebant arva coloni. VIRG. Georg. lib.
Diique Deæque omnes ſtudium quibus arva tueri,
Quique novas alitis nullo de ſemine fruges,
Quique ſatis largum cœlo demittitis imbrem. *Id.* lib. 1.

Pan

ſtructed men in the art of agriculture; and a variety of inferior deities were repreſented as preſiding over the different fruits of the earth, and the operations of nature in bringing theſe fruits to maturity, to reward the toil of the huſbandman. In all the ſeaſons of the year, different feſtivals were appointed, upon which the magiſtrates went in proceſſion to the temples of the gods, and ſometimes to the fields, to offer up prayers for the ſafety of the crop, or of the cattle, and for ſucceſs in every agricultural undertaking.

The political inſtitutions of the ſtate were all calculated in a ſimilar manner to confer reſpectability upon the practice of this art. In the early ages of the republic, the individual ſoldiers of a victorious army were each put in poſſeſſion of his portion of the conquered territory, with all the ſolemnity and parade of a military proceſſion, thereby giving dignity to the labours of the huſbandman, by aſſociating them with the proud ideas of conqueſt and dominion. Hence, the perſons engaged in any branch of art or manufacture, or in any commercial employment, were regarded as an inferior claſs, and as holding a far lower rank in ſociety than the meaneſt huſbandman, or perſon engaged in the cultivation of the ſoil. One of the puniſhments which the public cenſors or inſpectors of morals, ſometimes inflicted upon a diſorderly citizen, conſiſted of ſtriking his name out of the liſt of the inhabitants of the country, and of enrolling him among the city tribes.

The

Pan curat oves oviumque magiſtros, Virg. *Eclog.*
Et ruber, hortorum decus et tutela Priapus. Ovid. *Faſt.* lib. 1.
Populus Alcida gratiſſima, vitis Iaccho. Virg. *Eclog* 7.
Montium cuſtos nemorumque virgo. Horat. *Ode* 16. lib. 1.

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The very high degree of reſpect in which agriculture was held among the ancient Romans, explains what has often appeared a ſtrange circumſtance in their hiſtory, that after they had made conſiderable conqueſts, they ſhould ſtill have employed as conſuls, dictators, and commanders of mighty armies, men accuſtomed to ſupport themſelves by holding the plough upon their own farms. In this there is nothing wonderful. Among the Romans, the huſbandmen were accounted the moſt reſpectable order of ſociety. Their morals were the pureſt, and the young men of this claſs formed the military ſtrength of the ſtate. As in modern Europe, a nobleman or gentleman with little private property, is often employed to conduct fleets and armies, on account of the reſpectability of his birth, talents, and education; the Romans in like manner diſregarded private wealth in the choice of their leaders, but at the ſame time ſelected them from the moſt reſpectable and warlike, that is, the agricultural claſs of their citizens. Examples of this ſort of preferment, tended to preſerve to a very late period a taſte for agriculture and for frugal manners. Hence, the moſt illuſtrious ſenators of the empire, in the intervals of public concerns, applied themſelves to this profeſſion; and ſuch was the ſimplicity of thoſe ages, that they aſſumed no appearance of magnificence and ſplendour, or of majeſty, but when they appeared in public. At their return from the toils of war, the taking of cities, and ſubduing of hoſtile nations, their greateſt generals were impatient till they were again employed in the arts of cultivation.

Regulus, when in Africa, requeſted of the ſenate to be recalled, leſt his farm might ſuffer, for want of proper cultivation, in his abſence; and the ſenate wrote him for anſwer, that it ſhould be taken care of at the public expence, while he continued to lead their armies.

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Cato the cenſor, after having governed extenſive provinces, and ſubdued many warlike nations, did not think it below his dignity to write a Treatiſe on Agriculture. This work (as we are told by Servius) he dedicated to his own ſon, it being the firſt Latin treatiſe written on this important ſubject; and it has been handed down to us in all its purity, in the manner that Cato wrote it.

Varro compoſed a treatiſe on the ſame ſubject, and on a more regular plan. This work is embelliſhed with all the Greek and Latin erudition of that learned author, who died 28 years before the commencement of the Chriſtian æra. Virgil, who lived about the ſame time, has, in his Georgics, adorned this ſubject with the language of the Muſes, and finely illuſtrated the precepts and rules of huſbandry laid down by Heſiod, Mago, and Varro.

Columella, who flouriſhed in the reign of the emperor Claudius, wrote 12 books on huſbandry, replete with important inſtruction.

From this period to that of the reign of Conſtantine Poganatus, huſbandry continued in a declining ſtate; but that wiſe emperor cauſed a large collection of the moſt uſeful precepts relating to agriculture to be extracted from the beſt writers, and publiſhed them under the title of *Geoponics*. It has been aſſerted, that he made this collection with his own hand; and the truth of the aſſertion is not improbable, as it is well known, that after he had conquered the Saracens and the Arabians, he not only practiſed and encouraged, but ſtudied

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After the death of Conſtantine, however, the increaſing attention of the people to commerce, and the ignorance and groſs ſuperſtition of the ages which ſucceeded, ſeem to have rendered agriculture an almoſt neglected ſcience. The irruptions of the northern nations ſoon aboliſhed any improved ſyſtem. Theſe innumerable and enterpriſing barbarians, who overran all Europe, were originally ſhepherds or hunters, like the preſent Tartars and the ſavages of America. They contented themſelves with poſſeſſing, without labour or trouble, thoſe vaſt countries rendered deſerts by their own ravages, cultivating only a very ſmall ſpot near their habitations; and in this trifling huſbandry only the meaneſt ſlaves were employed: ſo that the art itſelf, which formerly was thought worthy of the ſtudy of kings, was now looked upon as mean and ignoble; a prejudice which is ſcarcely effaced at preſent, or at leaſt but very lately.—During this period, therefore, we find no veſtiges of any thing tolerably written on the ſubject.

The earlieſt efforts that were made in Europe towards the reſtoration of agriculture, after the conqueſt by the northern and eaſtern ſwarms of barbarians, appear to have occurred in Italy, which, after all its miſfortunes, ſtill continued to take the lead of the weſtern world, in whatever regarded the civilization of mankind and the improvement of the uſeful arts. But as the barbarians had introduced a pernicious notion, which remained long faſhionable in Europe, that labour was diſgraceful, and more eſpecially that kind of labour which is employed in the cultivation of the ſoil, it was long before hiſtorians began to take notice of agricultural improvements, or of any other events than thoſe petty wars which were at that period continually taking place among the free cities and feudal chieftains. One circumſtance, however, deſerves attention, as it ſufficiently marks the progreſs in agriculture that had been made by the Italians at a very early period; works of great expence and magnificence were formed in Lombardy during the middle ages, for the purpoſe of irrigation or with a view to water the ſoil.

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As the irrigation of the Milaneſe is perhaps the greateſt exertion of the kind that the world exhibits, and certainly was the firſt that was undertaken in Europe, after the decline of the Roman empire, it undoubtedly merits every attention, and ought to be held up to the view of the people of Great Britain, as an object in many inſtances well deſerving imitation. The water is there conveyed to every diſtrict of the country, in extenſive and noble canals, from which the graſs lands belonging to private perſons are periodically watered. All rivers or running ſtreams are declared by law to belong to the ſovereign, who ſells the waters to ſpeculators for the beneficial purpoſe of irrigation. It is ſometimes meaſured out by the length of time a certain quantity of water is allowed to run upon the lands, and ſometimes a ſtream of water proceeding through a tube or hole of a certain diameter from a canal, is ſold or let at the higheſt price it will bring. The property of ſuch ſtreams of water derived from canals, is often held in perpetuity, and diſpoſed of by a ſeparate tenure from the land. The practice is found ſo profitable both to the public and to private individuals, that the whole country, as far as poſſible, is interſected with canals, formed for the

History. purpoſe of conveying water to the lands. Every conſiderable ſpring that is found, becomes the origin of a new canal. He who diſcovers a ſpring, conducts it where he pleaſes, paying a fixed compenſation for cutting through the properties of others. "As an example of the beneficial influence of this law, (ſays Mr Arthur Young *) I was ſhewn between Milan and Pavia a ſpring, that was diſcovered two miles from the lands of the diſcoverer, the properties of many perſons lying between him and the ſpring. He firſt bought the property of the perſon in whoſe lands it was ſituated, which was eaſily done, as it was too low to be there of any uſe; then he conducted it by a trench at pleaſure the two miles, paying the fixed price for cutting through his neighbours lands, and having gained it upon his own, preſently changed poor hungry arable gravel into a very fine watered meadow." In the neighbourhood of the cities of Milan and of Lodi, the exertions in irrigation are the greateſt. Canals are not only numerous and uninterrupted, but are conducted with great ſkill and expence. Along the public roads there is almoſt everywhere one canal on the ſide of the road and ſometimes two. Croſs ones are thrown over theſe on arches, and paſs in trunks of brick or ſtone under the road. A very conſiderable one, ſays the above author, "after paſſing for ſeveral miles by the ſide of the highway, ſinks under it, and alſo under two other canals carried in ſtone troughs eight feet wide; and at the ſame place under a ſmaller that is conducted in wood. The variety

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* *Travels*, vol. ii.

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riety of directions in which the water is carried, the eaſe with which it flows in contrary directions, the obſtacles which are overcome, are objects of admiration. The expence thus employed, in the 20 miles from Milan to Lodi, is immenſe. There is but little rice, and ſome arable, which does not ſeem under the beſt management, but the graſs and clover rich and luxuriant; and there are ſome great herds of cows, to which all this country ought to be applied. I cannot but eſteem the 20 miles, as affording one of the moſt curious and valuable proſpects in the power of a farmer to view. We have ſome undertakings in England that are meritorious; but they ſink to nothing in compariſon with theſe great and truly noble works. It is one of the rides which I wiſh thoſe to take who think that every thing is to be ſeen in England."

It is not eaſy, amidſt the darkneſs of the middle ages, to diſcover the preciſe period at which theſe intereſting and valuable works were begun. In the year 1037, however, mention is made of the canal Vecchiabbia. In 1067, watered meadows were common, called *prato-roco* by Landolfo. In 1077 there are notes of many ſtreams uſed. In 1138, the monks of Chiarevalle bought of Giavanni Villano ſome commons, woods, and meadows, for 81 livres, under the contract, (a parchment yet remaining) "ut monaſterium poſſit ex Vecchiabbia trahere lectum ubi ipſum monaſterium voluerit; et ſi fuerit opus, liceat facere eidem monaſterio foſſata ſuper terram ipſius Johannis ab ima parte vice et ab alia . . . . &c. Poſſit firmare et habere cluſam in prato ipſius Johannis, &c." There is a ſimilar contract of the following year, and various others until the beginning of the 13th century; from which, and others, it appears that the Vecchiabbia

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gable. It is 32 Italian miles long, and 25 braccia wide, or 49 Engliſh feet. Hiſtory.

In 1220 was executed the ſecond great work or canal of this kind, which conveys the waters of the Adda from Caſſano to Marignano, where it waters much of the country around Lodi. In 1305, the canal of Treviglio was made, which takes the waters from the Brembo, and carries them for ſeveral miles, about 25 feet wide, and about three deep; it irrigates the territory of Treviglio and the Chiara d'Adda; and within four or five miles there are five canals, taken from the Adda and the Brembo, all of great antiquity. In 1460, the canal de Marteſano was begun under Duke Francis Sforza I.; it was 24 miles long, and 18 braccia (35 Engliſh feet) wide; ſince lengthened ſeven or eight miles more. It takes the waters of the Adda, a little before Trezzo, by means of a powerful wear (chiuſe) founded upon the living rock: it is then ſupported for five miles by a ſolid wall of ſtone 40 braccia (80 feet) above the bottom of the Adda, and parallel with it. At Gorgonſola, it paſſes over the torrent Molgora by a bridge of three ſtone arches. At Carſenſago it is croſſed by the river Lambro, which enters and quits the canal with all its floods. And in order to prevent the ſurplus of water which this circumſtance occaſions, from breaking the banks of the canal, or overflowing them, there are 19 *ſcaricatori* in the canal, above, below, and facing the junction, which are ſo calculated that they have not only powers ſufficient to take off the waters of that river, but alſo half of thoſe of the canal itſelf. Theſe ſcaricatori are canals which take the water when ſluice-gates are opened for that purpoſe, and convey it at various diſtances to the Lambro again, the fall in its

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courſe being conſiderable enough to free the canal from all ſuperfluity of water. The chief of theſe canals are ſo contrived as to be completely emptied once a-year, for cleaning and repairing whatever accidents may have happened to any of the works. Theſe facts ſhow how well that important branch of agriculture, which conſiſts of irrigation, and which is only of recent introduction among ourſelves, was underſtood in Italy, and how admirably it was practiſed when the countries on this ſide of the Alps were altogether barbarous.

On the general ſubject of agriculture at large, however, few Italian writers appeared till towards the end of the 15th century. In 1478 Creſcenzio publiſhed an excellent performance on the ſubject at Florence. This rouſed the ſlumbering attention of his countrymen, ſeveral of whom ſoon followed his example. Among theſe, Tatti, Steffano Auguſtino Gallo, Sanſovino, Lauro, and Tarello, deſerve particular notice.

At what time agriculture was introduced into Britain, is uncertain. When Julius Cæſar firſt invaded this iſland, it was not wholly unknown. That conqueror was of opinion, that agriculture was firſt introduced by ſome of thoſe colonies from Gaul which had ſettled in the ſouthern parts of Britain, about 100 years before the Roman invaſion*.

It is not to be expected that we can now be acquainted with many of the practices of theſe ancient huſbandmen. It appears, however, that they were not unacquainted with the uſe of manures, particularly marl. This we have on the authority of Pliny [†], who tells us, that it was peculiar to the people of Gaul and of Britain; that its effects continued 80 years; and that no man was ever known to marl his field twice, &c.—It is highly probable, too, that lime was at this time alſo uſed as a manure in Britain, it being certainly made uſe of in Gaul for this purpoſe at the time of Julius Cæſar's invaſion.

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* Cæſar *de Bell. Gall.* lib. v. c. 12.

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The eſtabliſhment of the Romans in Britain produced great improvements in agriculture, inſomuch that prodigious quantities of corn were annually exported from the iſland; but when the Roman power began to decline, this, like all the other arts, declined alſo, and was almoſt totally deſtroyed by the departure of that people. The unhappy Britons were now expoſed to frequent incurſions of the Scots and Picts, who deſtroyed the fruits of their labours, and interrupted them in the exerciſe of their art. After the arrival of the Saxons in the year 449, they were involved in ſuch long wars, and underwent ſo many calamities, that the huſbandmen gradually loſt much of their ſkill, and were at laſt driven from thoſe parts of their country which were moſt proper for cultivation.

After the Britons retired into Wales, though it appears from the laws made relative to this art, that agriculture was thought worthy of the attention of the legiſlature, yet their inſtruments appear to have been very unartful. It was enacted that no man ſhould undertake to guide a plough who could not make one; and that the driver ſhould make the ropes of twiſted willows, with

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[†] Plin. *Nat. Hiſt.* lib. xvii. cap. 6.

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our money: a very trifling price, even in compariſon with that of other commodities at the ſame time: for, by comparing other accounts, it appears, that four ſheep were then equal in value to an acre of the beſt land, and one horſe of the ſame value with three acres. The frequent and deplorable famines which afflicted England about this time, are further inſtances of the wretched ſtate of agriculture. In 1043, a quarter of wheat ſold for 60 Saxon pennies (15 of our ſhillings), at that time equal in value to ſeven or eight pounds of our money now.

The invaſion of the Normans, in 1066, contributed very much to the improvement of agriculture; for, by that event, many thouſands of huſbandmen from Flanders, France, and Normandy, ſettled in Britain, obtained eſtates or farms, and cultivated them after the manner of their country. The implements of huſbandry, uſed at this time, were of the ſame kind with thoſe employed at preſent; but ſome of them were leſs perfect in their conſtruction. The plough, for example, had but one ſtilt or handle, which the ploughman guided with one hand, having in his other hand an inſtrument which ſerved both for cleaning and mending the plough, as well as for breaking the clods. The Norman plough had two wheels; and in the light ſoil of Normandy was commonly drawn by one or two oxen; but, in England, a greater number was often neceſſary. In Wales, the perſon who conducted the oxen in the plough walked backwards. Their carts, harrows, ſcythes, ſickles, and flails, from the figures of them ſtill remaining, appear to have been nearly of the ſame conſtruction with thoſe that are now uſed. In Wales, they did not uſe a ſickle for reaping their corns, but

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but an inſtrument like the blade of a knife, with a wooden handle at each end.—Their chief manure, next to dung, ſeems ſtill to have been marl. Summer fallowing of lands deſigned for wheat, and ploughing them ſeveral times, appear to have been frequent practices of the Engliſh farmers in this period.

We are, after all, very much in the dark with reſpect to the ſtate and progreſs of agriculture in Great Britain previous to the fourteenth century. That it was pretty generally practiſed, eſpecially in the eaſtern, ſouth, and midland parts of England, is certain; but of the mode, and the ſucceſs, we are left almoſt totally ignorant. In the latter end of the fifteenth century, however, it ſeems to have been cultivated as a ſcience, and received very great improvement.

At this time Fitzherbert, judge of the common-pleas, ſhone forth with diſtinguiſhed eminence in the practical parts of huſbandry. He appears to have been the firſt Engliſhman who ſtudied the nature of ſoils and the laws of vegetation with philoſophical attention. On theſe he formed a theory confirmed by experiments; and rendered the ſtudy pleaſing as well as profitable, by realizing the principles of the ancients, to the honour and advantage of his country. Accordingly, he publiſhed two treatiſes on this ſubject: the firſt, intituled *The Book of Huſbandry*, appeared in 1534; and the ſecond, called *The Book of Surveying and Improvements*, in 1539. Theſe books, being written at a time when philoſophy and ſcience were but juſt emerging from that gloom in which they had long been buried, were doubtleſs replete with many errors; but they contained the rudiments of true knowledge, and revived the ſtudy and love of an art, the advantages of which

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In England, during the civil wars, though the operations and improvements in huſbandry ſuffered ſome temporary checks, there flouriſhed ſeveral excellent writers on the ſubject, and the art itſelf received conſiderable encouragement. Sir Hugh Platt was one of the moſt ingenious huſbandmen of the age in which he lived; yet ſo great was his modeſty, that all his works, except his Paradiſe of Flora, ſeem to be poſthumous. He held a correſpondence with moſt of the lovers and patrons of agriculture and gardening in England; and ſuch was the juſtice and modeſty of his temper, that he always named the author of every diſcovery communicated to him. Perhaps no man in any age diſcovered, or at leaſt brought into uſe, ſo many new kinds of manure. This will be evident to thoſe who read his account of the compoſt and covered dunghills, and his judicious obſervations on the fertilizing qualities lodged in ſalt, ſtreet dirt, and the ſullage of ſtreets in great cities, clay, fullers earth, mooriſh earths, dunghills made in layers, fern, hair, calcination of all vegetables, malt duſt, willow tree earth, ſoapers aſhes, urine, marl, and broken potſherds.

Gabriel Plattes may be ſaid to have been an original genius in huſbandry. He began his obſervations at an earlier period, in the reign of Queen Elizabeth, and continued them down to the Commonwealth. But notwithſtanding the great merit of this writer, and the eſſential ſervice he had rendered his country by his writings, the public ungratefully ſuffered him to ſtarve and periſh in the ſtreets of London; nor had he a ſhirt on his back when he died.

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Among theſe we may mention the writings of Captain Walter Blyth, on account of the very complete manner in which he appears to have underſtood the ſubject of irrigation or watering lands. In his principal work, called the *Engliſh Improver improved*, publiſhed in 1652, he gives directions for the practice of this branch of the art which mark great intelligence and obſervation, and would do no diſcredit to the experience of our own age.

Samuel Hartlib, a celebrated writer on agriculture in the 17th century, was highly eſteemed and beloved by Milton, and other great men of his time. In the preface to his work entitled his *Legacy*, he laments that no public director of huſbandry was eſtabliſhed in England by authority; and that we had not adopted the Flemiſh method of letting farms upon improvement. This remark of Hartlib's procured him a penſion of 100l. a-year from Cromwell; and the writer afterwards, the better to fulfil the intention of his benefactor, procured Dr Beatti's excellent annotation on the Legacy, with other valuable papers from his numerous correſpondents.

The time in which Hartlib flouriſhed ſeems to have been an era when the Engliſh huſbandry roſe to great perfection, compared with that of former ages; for the preceding wars had impoveriſhed the country gentlemen, and of courſe made them induſtrious. They found the cultivation of their own lands to be the moſt profitable

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Evelyn was the firſt writer who inſpired his countrymen with a deſire of reviving the ſtudy of agriculture; and he was followed by the celebrated Jethro Tull. The former, by his admirable treatiſes on earth and on planting, and the latter, by contending for the ſuperior advantages of the drill huſbandry, excited numbers to bring their theory to the teſt of fair experiment.

Many valuable and capital improvements have ſince that period been made in Engliſh huſbandry: and theſe great men have been ſucceeded by a variety of writers, who have performed the moſt eſſential ſervice to their countrymen, by enlightening their minds, and exciting them to emulation in this important art.

About the middle of the laſt century, Ireland began to make a conſiderable figure in the art of huſbandry. It muſt indeed be confeſſed, that the Iriſh had very ſtrong prejudices in favour of a wretched method of agriculture, till Blyth opened their eyes by his excellent writings. Since that time, a ſpirit of improvement has more or leſs been promoted, and in many inſtances carried on with great zeal, by the nobility, clergy, and gentry of that kingdom. In proof of this, it will be ſufficient to obſerve, that the Tranſactions of the Dublin Society for encouraging Huſbandry are now quoted by all foreigners in their memoirs relating to that ſubject. And the obſervations of that diſcerning and judicious

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dicious writer, Arthur Young, Eſq. in his Tour through that kingdom, ſhew, that in many reſpects improvements there have of late years made a progreſs nearly as rapid as in England.

About the year 1600, France made ſome conſiderable efforts to revive the art of huſbandry, as appears from ſeveral large works, particularly *Les Moyens de devenir Riche*; and the *Coſmopolite*, by Bernard de Paliſſy, a poor porter, who ſeems to have been placed by fortune in a ſtation for which nature never intended him; *Le Theatre d'Agriculture*, by Deferres; and *L'Agriculture et Maiſon Ruſtique*, by Meſſrs Etienne, Liebault, &c.

Nearly in the ſame period, the ſkilful practice of huſbandry became more prevalent among the Flemings, than the publiſhing of books on the ſubject. Their intention ſeemed to be that of carrying on a private lucrative employment, without inſtructing their neighbours. Whoever therefore became deſirous of copying their method of agriculture, was obliged to viſit that country, and make his own remarks on their practice.

The principal idea they had of huſbandry was, by keeping the lands clean and in fine tilth, to make a farm reſemble a garden as nearly as poſſible.

Such an excellent principle, at firſt ſetting out, led them of courſe to undertake the culture of ſmall farms only, which they kept free from weeds, continually turning the ground, and manuring it plentifully and judiciouſly. When they had by this method brought the ſoil to a proper degree of cleanlineſs, health, and ſweetneſs, they chiefly cultivated the more delicate graſſes, as the ſureſt means of obtaining a certain pro-

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fit upon a ſmall eſtate, without the expence of keeping many draught horſes and ſervants. A few years experience was ſufficient to convince them, that ten acres of the beſt vegetables for feeding cattle, properly cultivated, would maintain a larger ſtock of grazing animals than forty acres of common farm graſs on land badly cultivated. They alſo found, that the beſt vegetables for this purpoſe were lucerne, ſaintfoin, trefoil of moſt kinds, field-turnips, &c.

The grand political ſecret of their huſbandry, therefore conſiſted in letting farms on improvement. They are ſaid alſo to have diſcovered nine ſorts of manure; but what they all were, we are not particularly informed. We find, however, that marl was one of them; the uſe and virtues of which appear alſo to have been well known in this kingdom two hundred years ago, although it was afterwards much neglected. They were the firſt people among the moderns who ploughed in green crops for the ſake of fertilizing the ſoil; and who confined their ſheep at night in large ſheds built on purpoſe, the floors of which were covered with ſand or virgin earth, &c. which the ſhepherd carted away each morning to the compoſt dunghill.

After the peace of Aix-la-Chapelle, moſt of the nations of Europe, by a ſort of tacit conſent, applied themſelves to the ſtudy of agriculture, and continued to do ſo, more or leſs, amidſt the univerſal confuſion that ſucceeded.

The French found, by repeated experience, that they could never maintain a long war, or procure a tolerable peace, unleſs they could raiſe corn enough to ſupport themſelves in ſuch manner as not to be obliged to ſubmit to harſh terms on the one hand, or to periſh

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by famine on the other. This occaſioned the king to give public encouragement to agriculture, and even to be preſent at the making of ſeveral experiments. The great, and the rich of various ranks and ſtations, followed his example; and even the ladies were candidates for a ſhare of fame in this public-ſpirited and commendable undertaking.

During the hurry and diſtreſſes of France in the war of 1756, conſiderable attention was paid to agriculture. Prize queſtions were annually propoſed in their rural academies, particularly thoſe of Lyons and Bourdeaux; and many judicious obſervations were made by the Society for improving agriculture in Britanny.

After the concluſion of that war in 1763, matters were carried on there with great vigour. The univerſity of Amiens made various propoſals for the advancement of huſbandry; and the marquis de Tourbilly (a writer who proceeded chiefly on experience) had the principal direction of a georgical or agricultural ſociety eſtabliſhed at Tours.

The ſociety at Rouen, which made a conſiderable figure at the ſame period, alſo deſerves notice. In conſequence of encouragement from the government, there ſoon exiſted about fifteen ſocieties in France, eſtabliſhed by royal approbation, for the promoting of agriculture; and theſe had twenty co-operating ſocieties belonging to them.

After all, however, the hiſtory of the kingdom of France affords a ſtriking example how little can be done towards the improvement of agriculture, by the mere efforts of government, or of ſpeculative men, in publiſhing books or offering premiums for treatiſes upon the ſubject. The agriculture of the country at large, notwithſtanding all that was done in this way, ſtill

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continued in a very deplorable ſtate. In the years 1787, 1788, and 1789, when Mr Young made his agricultural tour upon the continent, it was ſuppoſed that nearly ſeven-eighths of the lands in France were held by *metayers*, that is, by the tenure which in Scotland anciently received the appellation of *ſteel-bow*, and which to this day is not unknown in the Highland diſtricts. By this tenure the landlord or proprietor ſtocked the farm with ſeed corn, cattle, and implements of huſbandry, while the tenant afforded nothing more than his labour. The produce was divided between the two parties in ſuch proportion as they could agree upon. "This tenure," ſays Mr Young, "pervades almoſt every part of Sologne, Berry, La Marche, Limoſin, Anjou, Bourgogne, Bourbonnois, Nivernois, Auvergne, &c. and is found in Bretagne, Maine, Provence, and all the ſouthern counties, &c. In Champagne there are many at *tier franc*, which is the third of the produce, but in genera it is half. The landlord commonly finds half the cattle and half the ſeed; and the metayer labour, implements, and taxes: but in ſome diſtricts the landlord bears a ſhare of theſe. In Berry ſome are at half, ſome one-third, ſome one-fourth produce. In Rouſſillon the landlord pays half the taxes; and in Guienne, from Auch to Fleuran, many landlords pay all. Near Aguillon on the Garonne, the metayers furniſh half the cattle. Near Falaiſe in Normandy I found metayers, where they ſhould leaſt of all be looked for, on the farms which gentlemen keep in their own hands; the conſequence there is that every gentleman's farm muſt be preciſely the worſt cultivated of all the neighbourhood. This diſgraceful circumſtance needs no comment. At Nangis, in the Iſle of France, I met with an agreement

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As the landlord to furniſh live-ſtock, implements, harneſs, and taxes; the metayer found labour and his own capitation tax; the landlord repaired the houſes and gates, the metayer the windows; the landlord provided ſeed the firſt year, the metayer the laſt; in the intervening years they ſupply half and half—Produce ſold for money divided. Butter and cheeſe uſed in the metayer's family, to any amount, compounded for at 5s. a cow. In the Bourbonnois the landlord finds all ſorts of live-ſtock; yet the metayer ſells, changes, and buys at his will, the ſteward keeping an account of theſe mutations; for the landlord has half the product of ſales, and pays half the purchaſes. The tenant carts the landlord's half of the corn to the barn of the chateau, and comes again to take the ſtraw. The conſequences of this abſurd ſyſtem are ſtriking; land, which in England would let at 10s. pays about 2s. 6d. for both land and live-ſtock."

“The tenants,” adds this excellent and accurate obſerver, are found in the loweſt ſtate of poverty, and ſome of them in miſery. At Vatan in Berry I was aſſured that the metayers almoſt every year borrowed their bread of the landlord before the harveſt came round, yet hardly worth borrowing, for it was made of rye and barley mixed. I taſted enough of it to pity the poor people; but no common perſon there eats wheaten bread. With all this miſery among the farmers the landlord's ſituation may be eſtimated by the rents he receives. At Salbris in Sologne, for a ſheep-walk that feeds 700 ſheep, and 200 Engliſh acres of other land, paid the landlord for his half about 33l. ſterling: the whole rent for land and ſtock too did not, therefore, amount to 1s. per head on the ſheep! In Limoſin the metayers are conſider-

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ed as little better than menial ſervants, removeable at pleaſure, and obliged to conform in all things to the will of the landlords. It is commonly computed, that half the tenantry are deeply in debt to the proprietor, ſo that he is often obliged to turn them off, with the loſs of theſe debts, in order to ſave his land from running waſte." The hard plea of neceſſity, continues the ſame author, can alone be urged in favour of this mode of cultivating land; "the poverty of the farmers being ſo great, that the landlord muſt ſtock the farm, or it could not be ſtocked at all. This is a moſt cruel burden to a proprietor, who is thus obliged to run much of the hazard of farming, in the moſt dangerous of all methods, that of truſting his property abſolutely in the hands of people who are generally ignorant, many careleſs, and ſome undoubtedly wicked. Among ſome gentlemen I perſonally knew, I was acquainted with one at Bagnere de Luchon, who was obliged to ſell his eſtate, becauſe he was unable to reſtock it; the ſheep having all died of epidemical diſtempers, proceeding doubtleſs from the execrable methods of the metayers, cramming them into ſtables, as hot as ſtoves or reeking dunghills; and then, in the common cuſtom of the kingdom, ſhutting every hole and crack that could let in air. In this moſt miſerable of all modes of letting land, after running the hazard of ſuch loſſes, fatal in many inſtances, the defrauded landlord receives a contemptible rent—the farmer is in the loweſt ſtate of poverty—the land is miſerably cultivated, and the nation ſuffers as ſeverely as the parties themſelves."

The great evil which prevented the tenantry of France from attaining to that reſpectable and eaſy ſituation which they have reached in Great Britain, and which

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which the publication of books, and the efforts of agricultural ſocieties could not remove, was the improper principles upon which their revenue laws have at all times been conducted. Heavy taxes were impoſed upon the farmers, from which the nobles and the clergy were exempt. Theſe taxes were impoſed arbitrarily upon individuals, according to the eſtimate formed of their wealth by the intendant of the province and his delegates; the reſult of which was, that although the ſovereign received only a moderate revenue into his exchequer, the cultivators of the ſoil were oppreſſed, in conſequence of the partiality with which the taxes were impoſed, according to the favour or diſlike of the inferior officers of the revenue. Hence the farmers, even when not really poor, pretended to be ſo, to eſcape the arbitrary riſe of a tax which was profeſſedly impoſed in proportion to their power of bearing it: They choſe therefore to have poor cattle, poor implements of huſbandry, and poor dunghills, even when they could have done otherwiſe. The reſult of the whole was, that the huſbandry of by far the greater part of France never roſe above a very low ſtate. They have in general no better mode of ameliorating the ſoil than merely by the uſe of a fallow year after every two white crops, the conſequence of which is, that notwithſtanding their fine climate, and their fertile ſoil, the produce of the Britiſh iſlands on a given extent of arable territory, is incomparably ſuperior to that of France; a circumſtance which perhaps affords ſome explanation of the political equality which has long exiſted between the two countries, notwithſtanding the magnitude of France and the natural advantages of its territory. As it is an important fact in the hiſtory of agriculture, that, of two rival

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nations, ſituated in the cloſe vicinity of each other, the one ſhould have poſſeſſed this art in a very high degree of perfection, while in the other it ſhould have remained in ſuch a ſtate of inferiority as could not fail to produce much weakneſs in every national effort; we ſhall here ſtate the compariſon made by Mr Young between the reſult of French and Engliſh agriculture, in the production even of wheat, which is the French favourite crop.

“ In order, (ſays this author), the better to underſtand how the great difference of product between the French and Engliſh crops, may affect the agriculture of the two kingdoms, it will be proper to obſerve that the farmer in England will reap as much from his courſe of crops, in which wheat and rye occur but ſeldom, as the Frenchman can from his in which they return often.

An Engliſh Courſe.	Buſhels per acre.	A French Courſe.	Buſhels per acre.
1. Turnips,		1. Fallow,	
2. Barley,		2. Wheat,	18
3. Clover,		3. Barley or oats,	
4. Wheat,	25	4. Fallow,	
5. Turnips,		5. Wheat,	18
6. Barley,		6. Barley or oats,	
7. Clover,		7. Fallow,	
8. Wheat,	25	8. Wheat,	18
9. Tares or beans,		9. Barley or oats,	
10. Wheat,	25	10. Fallow,	
11. Turnips,		11. Wheat,	18
	75		72

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"The Engliſhman in eleven years gets three buſhels more of wheat than the Frenchman. He gets three crops of barley, tares, or beans, which produce nearly twice as many buſhels per acre as what the three French crops of ſpring corn produce. And he farther gets at the ſame time three crops of turnips and two of clover, the turnips worth 40s. the acre, and the clover 60s. that is, 12l. for both. What an enormous ſuperiority! more wheat; almoſt double of the ſpring corn; and above 20s. per acre per annum in turnips and clover. But farther; the Engliſhman's land, by means of the manure ariſing from the conſumption of the turnips and clover is in a conſtant ſtate of improvement, while the Frenchman's farm is ſtationary. Throw the whole into a caſh account, and it will ſtand thus:"

ENGLISH SYSTEM.				FRENCH SYSTEM.			
Wheat 75 buſhels at 5s.	L.18	15	0	Wheat 72 buſhels at 5s.	L.18	0	0
Spring corn 3 crops at 32s. 96 buſhels at 2s. 6d.	12	0	0	Spring corn 3 crops at 20 buſhels, 60 buſhels at 2s. 6d.	7	10	0
Clover two crops	6	0	0				
	36	15	0		25	10	0
Per acre per annum,	3	6	10	Per acre per annum,	2	6	4

"In allowing the French ſyſtem to produce 20 buſhels of ſpring corn, while I aſſign 32 only to the Engliſh, I am confident that I favour the former conſiderably; for I believe the Engliſh produce is the double of that of France; but ſtating it as above, here are the proportions of 36 on an improving farm, to 25 on a ſtationary one; that is to ſay, a country containing

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The effect of the French revolution upon the ſituation of the perſons immediately engaged in agriculture, was not a little ſingular. While the higheſt orders of ſociety were driven into exile, or exiſted in terror, and while the inhabitants of the cities ſuſtained the greateſt hardſhips from the annihilation of all commerce, this terrible tempeſt paſt in a manner comparatively light and harmleſs over the heads of the obſcure and ſcattered cultivators of the ſoil. In many quarters of the country their condition was even greatly and rapidly ameliorated. By the confiſcation of the church lands, and of the eſtates of the emigrant nobles, the government for the time came to hold the property of a great part of the country. This government had too much buſineſs upon hand, to be able to levy correctly the rents of the property that had fallen into its poſſeſſion; and for ſome time it had no occaſion to do ſo, in conſequence of the ſupport which it derived from the iſſue of an immenſe paper currency. As this paper was a legal tender of payment in all tranſactions, and for all debts, thoſe farmers who held their lands for payment of a money rent, took care to pay their landlords with paper, which they ſoon obtained at a cheap rate, while they themſelves contrived to diſpoſe of the produce of their farms for caſh. Hence, a landlord, after the aſſignats had ſunk in value, was often under the neceſſity of diſpoſing of a part of his moveables to purchaſe from his own farmers a part of the grain which grew upon his own lands. In this way, by one means or other, a great proportion of the farmers in France found means during ſome years to avoid paying any rent whatever, and thus great numbers of them roſe to ſudden opulence, amidſt the general calamities of their country. Many perſons alſo perceiving the ſecurity of a country life, inveſted whatever money they had been able to ſave from the wrecks of other employments in agriculture, and became farmers or ſmall proprietors. We have hitherto had too little connection with that country to be able to aſcertain with accuracy, the effect of ſuch a change of circumſtances upon the practice of agriculture. It is underſtood, however, upon the whole, from inſpecting the face of the country, that the agriculture of France is not conducted upon more enlightened principles than formerly: the general appearance of the ſoil ſtill exhibits only white crops or fallow; the cattle are few; little manure therefore is prepared. Hence, the crop produced is always greatly inferior to what the land by more ſkilful arrangements might be made to bear.

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Of the hiſtory of the agriculture of the reſt of the continent of Europe we have little information, though ſome valuable practices made uſe of in particular ſituations will be afterwards noticed under their proper heads. In Germany, after the ruinous war of 30 years was brought to a termination by the treaty of Munſter or Weſtphalia in 1648, agriculture was gradually diffuſed and improved in that vaſt country. In the Proteſtant ſtates, at leaſt, the art appears to be much better underſtood than in France. For many years it has been publicly taught in various univerſities, and during the laſt half of the late century great attention was paid to its improvement by many princes of the Empire. In Ruſſia, vigorous exertions have repeatedly been made by the government to introduce, as far as poſſible into that climate, History. climate, the moſt approved ſyſtems of huſbandry, which have been eſtabliſhed in other parts of Europe. The late empreſs ſent ſeveral gentlemen into Britain and other countries to ſtudy agriculture, and gave it all the encouragement in her own dominions which the nature of her government, and the enſlaved and barbarous ſtate of the lower claſſes of her people, would permit. Even Italy, during the ſame period, was not inactive. The Neapolitans condeſcended to recur to the firſt rudiments of revived huſbandry, and began to ſtudy anew the agricultural ſyſtem of Creſcenzio, firſt publiſhed in 1478. In Bergamo the ſame plan was purſued, and a new edition was given of the Recordo d'Agriculturæ de Tarello, firſt publiſhed in 1577. The patriotic ſociety of Milan exhibited ſpecimens of ability, and enlightened information upon this important ſubject, which entitle it to a reſpectable place among the literary aſſociations of Europe. The duchy of Tuſcany, eſpecially under the late Archduke Leopold, afterwards emperor of Germany, imbibed the ſame ſpirit of improvement. A private gentleman there, upwards of 40 years ago, left his whole fortune to endow an academy of Agriculture. The firſt eccleſiaſtic in the duchy was preſident of this ſociety, and many of the chief nobility were members. But the events of the late war, by which Italy from the Alps to the gulf of Tarentum ſuffered ſo much, muſt undoubtedly for a time have injured the progreſs of agriculture, as well as of every other valuable art.

In the year 1759, a few ingenious and public-ſpirited men at Berne in Switzerland eſtabliſhed a ſociety for the advancement of agriculture and rural economics. In that ſociety were many men of great weight in the republic, and moſt of them perſons of a true caſt for making improvements in huſbandry, being enabled to join the practice with the theory.

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Nor muſt we here omit to mention, that the juſtly celebrated Linnæus and his diſciples have made great efforts in the north of Europe, particularly in diſcovering new kinds of profitable and well-taſted food for cattle. About the ſame time, Sweden beſtowed ſucceſsful labours on a ſoil which had before been looked upon as cold, barren, and incapable of melioration. Of this the Stockholm Memoirs will be a laſting monument.

Denmark, and many of the courts of Germany, followed the ſame example. Woollen manufactures were encouraged; and his Daniſh majeſty ſent three perſons into Arabia Felix to make remarks and bring over ſuch plants and trees as would be uſeful in huſbandry, building, and rural affairs.

Neither muſt we forget the very aſſiduous attention of of the learned in Leipſic and Hanover to this important object. During the rage and devaſtation of a long war, they cultivated the arts of peace; witneſs the *Journal d'Agriculture* printed at Leipſic, and the *Recueils d'Hanover* printed in that city.

Even Spain, conſtitutionally and habitually inactive on ſuch occaſions, in ſpite of all her natural indolence, and the prejudices of bigotry, invited Linnæus, with the offer of a large penſion, to ſuperintend a college founded for the purpoſe of making new inquiries into the hiſtory of nature and the art of agriculture.

But, without any improper partiality to our own country, we are fully juſtified in aſſerting, that Britain alone exceeds all modern nations in huſbandry;

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and from the ſpirit which for the laſt twenty years has animated many of our nobility and gentry, to become the liberal patrons of improvement, there is reaſon to hope that this moſt uſeful of arts will, in a few years, be carried to a greater pitch of perfection than it has ever yet attained in any age or country.—The Royal Society, the Bath Society, and the Society of Arts, &c. in particular, have been ſignally uſeful in this reſpect; and the other aſſociations, which are now eſtabliſhed in many parts of the kingdom, cooperate with them in forwarding their laudable deſigns.

It is not, however, to the exertion of public ſocieties, excellent and honourable as they are, that all our modern improvements in agriculture owe their origin. To the natural genius of the people, and the mildneſs and wiſdom of the government, have been added the theory and practice of all nations in ancient and modern times. This accumulated maſs of knowledge has been arranged, divided, and ſubdivided; and after paſſing the teſt of practical experiments, the eſſential and moſt valuable parts of it have been preſerved, improved, and amply diffuſed in a variety of valuable publications upon this great art of rendering mankind happy, wealthy, and powerful, particularly in the works of Stillingfleet, Lord Kaimes, Dr Hunter, Dr Anderſon, Mr Marſhall, Mr Kent, The Reverend Mr Dickſon, and various others, but more eſpecially in the compilations and treatiſes publiſhed by Arthur Young, Eſq. already mentioned.

Board of Agriculture.

We alſo remark with much ſatisfaction, that the Britiſh government has of late years thought fit to render the improvement of agriculture an object of public attention and encouragement, by the inſtitution of a

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board of agriculture.—About the year 1790, Sir John Sinclair, Bart. invited the clergy of the church of Scotland to tranſmit to him deſcriptions of the ſtate of their different pariſhes, with a view to the publication of what is called a *Statiſtical Account of Scotland.* The whole members of this body having readily complied with his requeſt, a work in 20 volumes octavo was compiled from the materials afforded by them, containing an account of the agriculture, manufactures, and population of the country. The ſame gentleman, about that period, was alſo active in obtaining the inſtitution of a private ſociety, called *The Britiſh Wool Society*, which was very ſucceſsful in calling the attention of the public to the improvement of that important article of national growth and manufacture. By theſe patriotic exertions, having acquired a conſiderable ſhare of popularity, he was encouraged on the 15th May 1793, to make a motion in the houſe of commons, of which he was a member, for an addreſs to the crown, recommending the inſtitution of a board of agriculture. The chancellor of the exchequer, Mr Pitt, on perceiving that the propoſal was acceptable to the majority of the houſe, gave it a decided ſupport, and on the 17th May, to which the debate had been adjourned, the motion was carried for an addreſs to his majeſty to inſtitute ſuch a board, at an expence not exceeding 3000l.—In conſequence of this application, a charter paſſed the great ſeal, incorporating the members of adminiſtration for the time, with the archbiſhops of Canterbury and York, and all their ſucceſſors in office, together with certain other noblemen and gentlemen, into a board or ſociety, by the name of the *Board* or *Society for the encouragement of Agriculture and internal improvement*, under the patronage

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tronage of the crown; with power to the members to elect office-bearers and ſucceſſors to themſelves: and in the mean time Sir John Sinclair was appointed to be the firſt preſident, to continue in office till the 25th March following; Sir John Caul, Bart. was appointed to be the firſt treaſurer, and Arthur Young, Eſq. was appointed ſecretary.

Commencement of its ſittings.

The regular ſittings of the board did not commence till 23d January 1794, ſince which time it has continued to exert a very conſiderable degree of activity in eſtabliſhing an extenſive foreign correſpondence, and in procuring and publiſhing every kind of uſeful domeſtic agricultural intelligence, ſome ſpecimens of which we ſhall afterwards have occaſion to notice. This board, ſoon after its inſtitution, alſo employed perſons of known reputation to prepare agricultural ſurveys of every county in the iſland of Great Britain.—Many of theſe ſurveys have been publiſhed, and form treatiſes upon this important art, which, for extent of intelligence and ability of execution, have not been exceeded in any age or country. The board has alſo obtained parliamentary rewards to ſome individuals for important diſcoveries, and has offered premiums for eſſays or treatiſes upon ſubjects connected with the purpoſe of its inſtitution, which have produced a great variety of valuable and ingenious diſquiſitions.

More particularly, in conſequence of the late extraordinary dearth and ſcarcity of proviſions, the legiſlature thought fit to have recourſe to the aſſiſtance of the board for the purpoſe of endeavouring to alleviate the evil. In December 1800, a committee of the houſe of lords, with a view to extend the cultivation of grain, required the board to make out a report upon the beſt

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means of converting graſs lands into tillage without exhauſting the ſoil, and of returning the ſame to graſs after a certain period in an improved ſtate, or at leaſt without injury. The Board having taken the ſubject into conſideration, reſolved that the beſt mode of inducing landlords to permit graſs lands to be ploughed, would be to convince them that they may do it in many caſes, not only without injury, but alſo to their advantage. In conſequence of this reſolution, an advertiſement was publiſhed by the Board, offering very liberal premiums for the moſt ſatisfactory eſſay upon the ſubject. This advertiſement produced a great number of diſquiſitions or eſſays, the greater part of which were written by candidates for the premiums, but ſome of them were the productions of public-ſpirited gentlemen who made no ſuch claim. From the whole number ſeveral eſſays have been ſelected and publiſhed by the Board, and form a very valuable volume, upon an intereſting part of the moſt important of all ſubjects in the art of agriculture, the rotation or ſucceſſion of different crops upon the ſame ſoil.

This affords an example of the utility of an inſtitution acting, like the Board of Agriculture, under the ſanction of the legiſlature. It enjoys the means of directing the attention of men of talents in all parts of the country, to any ſubject upon which practical information may be wanted; and it poſſeſſes the means of communicating to the public at large, in the moſt advantageous manner, whatever information may be obtained from the communications made to it. But although the diffuſion of the knowledge of the principles of any art affords at all times the beſt means of its improvement, this undoubtedly is only a part of the duty

of

Hiſtory. of ſuch a public body as the Board of Agriculture. Public eſtabliſhments and efforts are in many caſes neceſſary towards carrying the art to its ultimate perfection. Means ought to be adopted in all the great ſeminaries of learning for rendering the knowledge of its principles a part of a liberal education. Obſtacles to its progreſs, ariſing from tythes, rights of commonty, &c. ought to be removed; and it may even be found advantageous to give public aſſiſtance towards the erection of works which may prove too expenſive to be undertaken by individuals for the purpoſes of irrigation, in the ſame manner as has been done in other countries, as already mentioned. In theſe and all ſimilar caſes, it becomes the duty and the moſt valuable privilege of a board eſtabliſhed by public authority to give counſel to the legiſlature, to ſuggeſt improvements, and to urge the expenditure of money upon public works, in caſes where the advice of individuals might be diſregarded, or liſtened to under the ſuſpicion of its being prompted by views of private intereſt.

THEORY

OF

AGRICULTURE.

IN an art that is ſo neceſſary to mankind, and that has been ſo univerſally practiſed, it might perhaps be expected, that the principles upon which its operations depend, would have been by this time completely and accurately inveſtigated, and conſequently that a correct theory of agriculture could eaſily be exhibited. This, however, is by no means the caſe; and it is not a little ſingular, that, in this moſt uſeful of all arts, the theory ſhould ſtill be more defective than in almoſt any ſcience with which we are acquainted. It is fortunate, however, for the human race, that in moſt caſes, or at leaſt in all important arts, they ſucceed better in practice than in ſpeculation. During many ages, various artiſts were accuſtomed to extract the moſt ordinary, but moſt uſeful metals, from the ſtate of ore or earth in which nature produces them, and to reduce them back from their metallic form and luſtre, to a ſtate of ore or earth again. Theſe artiſts were unacquainted with the principles upon which the ſucceſs of their operations depended; and it is only within theſe few years that ſome ingenious chemiſts have ſucceſsfully inveſtigated the nature of theſe proceſſes, and have ex-

General Remarks.

The theory of agriculture is defective.

General Remarks.

plained what they have called the oxygenation and diſ-oxygenation of metals. The ſame thing has happened in agriculture. Men have often cultivated the ground well, while they have ſpeculated ill concerning the mode of doing ſo.

Difficulty of forming it.

Various reaſons render it ſtill more difficult to form a complete theory of agriculture, than of chemiſtry, mechanics, or other arts. In agriculture, an experiment cannot be made in an inſtant, or even in an hour, or in a day or two. A whole ſeaſon muſt paſs away before a ſingle experiment can be performed, and after all, as in other arts, the inquirer after truth may be miſled by ſome unobſerved circumſtances. Some fact, quite foreign to the experiment itſelf, ariſing out of the peculiar ſtate of the ſoil, or of the train of ſeaſons, may produce plentiful crops for a year or two, though, in ordinary circumſtances, no ſuch effect would follow; and the ingenious contriver of the experiment, who thought he had made an important diſcovery, may afterwards derive from it only diſappointment and mortification. But human life is too ſhort to admit of a very great variety of agricultural experiments to be performed by the ſame individual. After a few ſeaſons, he muſt leave his place to be occupied by a new inquirer, poſſeſſed of a different character and of different views. Unfortunately, till of late years, it was not uſual for huſbandmen to publiſh, and thus to immortalize and diffuſe over whole nations, the reſult of their private experience and reflections. Scattered over the face of great countries, and having little intercourſe with foreigners, or even with each other, they knew little of what was done by men engaged in the ſame profeſſion, though at no great diſtance.—In this way, the benefit

of

Diviſion of the Subject.

of local diſcoveries was not communicated to the world at large, nor was an opportunity afforded of eradicating local prejudices and erroneous practices. As the ſtate of this valuable profeſſion is now rapidly altering in theſe reſpects, there is little doubt that we are faſt approaching towards a period at which it will be poſſible to exhibit a clear and correct theory of agriculture, or to arrange under a few ſimple heads the rules or principles upon which the practice of the art depends.—What we are now to offer, is not to be conſidered as perfect, nor even as poſſeſſing any nearer approximation towards a perfect theory of the huſbandman's art; but merely, ſuch a general ſtatement of its principles as reſults from the degree of information hitherto collected upon the ſubject.

What it ought to contain.

A theory, or general view of the principles of agriculture ſeems neceſſarily to reſolve itſelf into the two following inveſtigations: 1ſt, To inquire, among the great variety of vegetables that exiſt in nature, what particular plants ought to be regarded as moſt worthy of cultivation: and, 2dly, To conſider the beſt mode of cultivating with ſucceſs the plants thus ſelected.

The value of vegetables is abſolute and relative.

With regard to the firſt of theſe diviſions of the ſubject, or the vegetables that ought to be choſen as moſt valuable and worthy of cultivation, it may be obſerved, that the value of a plant is of two kinds, *abſolute*, or *relative*: The *abſolute* value of a plant depends upon its fitneſs to afford ſubſiſtence to the human ſpecies, whereas its *relative* value conſiſts of the tendency which the cultivation of it will have to enrich a particular huſbandman, or claſs of huſbandmen, either becauſe their lands are well adapted for its growth, or becauſe there

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is a ready market for it in the vicinity, where it bears a high price.

They are uſeful directly and indirectly.

Concerning the abſolute value of plants, or their tendency to afford ſubſiſtence to mankind, it is to be obſerved, that ſome plants are *directly* uſeful or valuable, becauſe they are immediately conſumed as food by man, ſuch as wheat, oats, or potatoes; whereas mankind derive ſubſiſtence from another claſs of plants, only in an *indirect* manner, by giving them to cattle, and afterwards eating the fleſh of theſe cattle, as happens with regard to graſs and ſtraw of all kinds.

SECT. I.

OF VEGETABLES TO BE CULTIVATED AS FOOD FOR MAN.

Men feed on fruits and roots.

Some vegetables afford ſubſiſtence to the human ſpecies by means of the fruit that grows upon them, which hangs, and is brought to maturity in the air, at the ſummit of their ſtems. Other vegetables derive their value from producing roots, which come to maturity in the boſom of the ſoil, and are dug from thence to be conſumed by mankind.

Fruit trees not truſted to for food,

Of fruit-bearing vegetables, thoſe called *trees*, which riſe aloft with a ſtrong trunk, are the moſt permanent and remarkable. It is ſaid that a ſpot of ground, occupied by ſome kinds of trees, ſuch as cheſnuts or dates, is capable of producing a very great portion of food, uſeful for the ſupport of the human ſpecies. One advantage attending the cultivation of ſuch vegetables, would be that, after the trees are planted, and ſecured by fences for a few years againſt animals, they would for

ever

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ever after, or at leaſt for many years, continue to grow and flouriſh without care or labour. It does not appear, however, that in any nation of ancient or modern times, foreſts of fruit-bearing trees have been reared with a view to afford ſubſiſtence to the community. For this two reaſons may be aſſigned. In the firſt place, a conſiderable number of years muſt elapſe, before ſuch plants could arrive at maturity, and fulfil the purpoſe of their deſtination. Of whatever uſe, therefore, they might be to future ages, it is evident that they could afford little benefit to the generation which planted them. But in a queſtion about ſubſiſtence, mankind are uſually under the neceſſity of conſidering their own immediate wants, and hence they have been led to the cultivation of ſuch plants, as afford the moſt ſpeedy reward for the efforts of their induſtry. Another reaſon for preferring the culture of ſmall annual plants, to the greater and more permanent productions of nature, would ariſe, in the early ages of the world, from the turbulent ſtate of ſociety and the frequency of wars. A community that ſhould depend for its ſubſiſtence upon the fruit of foreſt trees, might be ruined for half a century by the inroad of an enemy. An example of this was exhibited in the war between Great Britain and her North American colonies. When the parent ſtate hired the ſavages on the weſtern frontier, to join her party and to make inroads upon the coloniſts, the latter retaliated upon the ſavages in the following manner. Several of the colonies united in ſending an expedition againſt the Indians. The bodies of militia employed upon this expedition, were ſurpriſed to find ſmall corn fields around a conſiderable number of the Indian hamlets. They were not ſatisfied however with deſtroying the huts of the natives, and theſe incipi-

becauſe they ripen ſlowly, and are deſtroyed in war.

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ent efforts of ſavage induſtry; but they anxiouſly ſought out and deſtroyed every fruit-bearing tree that they found in their progreſs of almoſt a thouſand miles, thereby rendering the wilderneſs utterly uninhabitable to a people deſtitute of agriculture, and who could not always depend for ſubſiſtence upon their ſucceſs in hunting. From this example we ſee that the frequent wars ariſing from the barbarous character of ancient nations, would compel them to ſeek ſubſiſtence, not from the fruit of foreſt trees, but from grain, which ſpeedily arrives at maturity, and which when deſtroyed can ſoon be renewed. Thus war becomes a leſs waſteful ſcourge to the human race, and communities are enabled ſpeedily to recover from the devaſtation which it produces. Had the nations of Europe depended for ſubſiſtence upon any fruits which could not be ſpeedily reſtored when deſtroyed, it is evident, that, in the late ſanguinary conflict, the greater number of them muſt have been irretrievably ruined.

Men rather truſt to grain.

Hence it appears that the cultivation of plants of annual growth, as a ſource of ſubſiſtence, is favourable to the permanence of civilization in the world; and that before nations can venture to rely for their ſubſiſtence upon the fruit of plants of ſlower growth, their character muſt have arrived at a degree of moral amelioration far ſuperior to what it has ever been known to poſſeſs.

Of annual plants cultivated for fruit, wheat has always been accounted the moſt valuable. This has probably ariſen from the extreme facility with which the flour of it undergoes a proceſs of fermentation, which renders it capable of becoming a more light and agreeable kind of bread than the flour of any other grain.

This

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This quality is believed to ariſe from a quantity of a ſubſtance contained in wheat that is of the ſame nature with the gluten, or glue, that is prepared from animal bodies. In other reſpects, however, it does not appear that wheat is more valuable than ſome other kinds of grain: by means of long boiling, a given weight of barley, or even of oats, will render a quantity of water as thick or full of mucilage as can be done by the ſame weight of wheat.

Oats a valuable grain.

After wheat, oats have in our country been conſidered as of very great importance. It is a hardy and beautiful plant; grows with little cultivation, and is particularly well ſuited for lands newly brought in from a ſtate of nature, upon which it was always uſed as the firſt crop, till the introduction of the turnip huſbandry. The meal of it is uſually very coarſely grinded, and mixed with a conſiderable quantity of the inner covering of the grain. Hence it has always a conſiderable degree of roughneſs, and is harſh and unſuited to very delicate conſtitutions; but this very harſhneſs, from its ſtimulant effect, producing a feeling of warmth in the ſtomach, renders it more grateful to perſons much expoſed to the open air, and accuſtomed to hard labour, who account it a hearty kind of food. Eſſentially, and in its intrinſic qualities, this grain differs little from ſome others.

Barley valuable from its eaſy converſion to a ſaccharine ſubſtance.

Barley is chiefly valued in conſequence of the facility with which it produces a great quantity of ſaccharine matter by the proceſs of vegetation or malting, which fits it for the preparation of vinous or ſpirituous liquors. Peaſe are alſo ſometimes uſed when grinded into meal as an article of human food; but, on account of their viſcid and indigeſtible quality, they can never become

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become valuable in that point of view, unleſs to perſons engaged in the open air, in the moſt active and ſevere kinds of labour.

Different kinds of grain are not eſſentially different.

In other reſpects, however, it does not appear that there is much difference in point of quality or wholeſomeneſs between the various kinds of grain cultivated in different countries. They are all capable of affording nouriſhment to the human conſtitution, and of preſerving it in health and vigour: When grinded into meal, they require little farther preparation, and are eaſily made into bread, or otherwiſe prepared for immediate conſumption, by being mixed according to the fancy or taſte of different nations, with a ſmall quantity of water, or any other liquid.

Roots uſed as human food.

Of the roots which are uſed to afford ſubſiſtence to man, the potato has hitherto been the principal. The reſt, conſiſting chiefly of carrots, turnips, and parſnips, are never uſed as a ſole nutriment, being rather adopted for the purpoſe of giving variety and reliſh to other food, and chiefly to butchers meat. The potato, however, is in ſome meaſure an exception to this general rule. It contains a large quantity of ſtarch, which does not ſeem inferior to the ſtarch prepared from wheat, ſo far at leaſt as that ingredient is to be regarded as contributing to the nouriſhing qualities of the grain. Its taſte reſembles, more nearly than any other root, the taſte of bread; and accordingly it is daily beginning to be more extenſively uſed, and to form a larger portion of the food of the poor. The celebrated Dr Adam Smith long ſince remarked its tendency to produce a ſtrong and handſome race of people, as demonſtrated by its effect upon the common people of

Ireland, who have for a conſiderable length of time in a great meaſure ſubſiſted upon it.

They produce more food on the ſame extent of ſoil than grain.

It is to be obſerved concerning all the roots now mentioned, that a crop of them always contains a much larger quantity of human food than a crop of any kind of grain, upon the ſame extent of ground. A Scots acre of good land, which will not produce more than 1280 pounds weight of oatmeal, will eaſily produce 16,000 pounds weight of potatoes, and will ſometimes in favourable ſeaſons produce 25,000 or 30,000 pounds weight of that valuable root. Suppoſing one pound of oatmeal to contain as much nouriſhment as two pounds and a half of potatoes, ſtill it is evident, that, where an extent of territory employed in the production of oats can only ſupport one million of people, the ſame territory employed in the cultivation of potatoes will ſupport five millions of perſons.

Their defect as food. The tranſportation of them expenſive.

Potatoes, however, and all the other roots, have hitherto poſſeſſed theſe radical defects: The carriage of them is extremely expenſive, in conſequence of their weight, ariſing from the vaſt quantity of moiſture they contain. Hence they can only be cultivated in abundance in the vicinity of great towns, or where they are meant to be conſumed upon the farm as the food of cattle.

Are unfit for long preſervation.

Roots are alſo incapable of long preſervation. In the winter they are deſtroyed by froſt, and in ſummer by heat, which cauſes them to vegetate or to corrupt; both of which changes render them unfit to be uſed as food.

Too bulky for the ſtomach.

Theſe roots are alſo much more bulky than grain in proportion to the quantity of nouriſhment contained in them. Hence they are rendered leſs fit to be conſumed

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med by perſons engaged in ſedentary profeſſions. Such perſons accordingly ſeldom fail to find them hurtful to the ſtomach, by their bulkineſs, and their tendency to injure the powers of digeſtion, by producing flatulencies and other unpleaſant conſequences.

Wherein they differ from grain.

On the whole, the difference between theſe ſucculent roots and the grain of corn plants ſeems to amount to this, that, although they are both formed of ſimilar ſubſtances, the potato being analogous to wheat, and the carrot and parſnip to rye, or rather to barley, after it has been converted into malt, yet, as the roots are formed in the boſom of the ſoil, and are of a looſe and watery texture, their formation requires from nature a ſlighter effort than the bringing to perfection the ſmall grains which are produced in the air at the top of corn plants. She therefore compenſates, by an abundant crop, the diminiſhed quality of her work.

How they may be rendered equal in value to grain.

Hence it has appeared an important problem in economics, to deviſe a plan by which the ſucculent roots of vegetables may be deprived of their ſuperfluous moiſture, that thus human art may perform for them what nature has not accompliſhed; and that they may be rendered completely equal in value to grain in point of quality, while in quantity they are ſo ſuperior. With this view different proceſſes have been adopted.

Potato-ſtarch.

Potatoes have been grated down in their raw ſtate, and repeatedly waſhed with water; the reſult of which operation is, that the ſtarch contained in them is obtained with great labour, but the reſt of the root is loſt; and this operation cannot be applied to other kinds of roots with ſucceſs.

Grenet's mode of granulating potatoes.

Another mode of accompliſhing the object was deviſed a few years ago by M. Grenet, and publiſhed in the Journal of the Lycæum of Arts of Paris. It is performed in this manner: The potatoes muſt firſt be boiled by the heat of the ſteam of boiling water, without touching the water itſelf. They are then ſtript of their ſkin, and allowed to cool, and made uſe of in the following way:—A white-iron tube of two inches diameter, and eight inches in length, open at the one end and cloſe at the other, is everywhere perforated with ſmall holes, and a round piece of wood is prepared, which eaſily goes into the tube, but which at the ſame time fills it. Things being thus in readineſs, a quantity of the potatoes, boiled as already mentioned, is put into the tube till it is full. They are then forcibly rammed down with the round piece of wood or piſton; the conſequence of which operation is, that they are forced through the little holes in the ſides of the tube, and come out in the ſhape of worms. They are received upon linen cloths, covered with unſized paper, and dried in the heat of the ſun, or in a warm room. The ſmall pieces muſt be ſtirred from time to time; and it is ſaid, that in leſs than 12 hours, the preparation dries ſo as to be capable of being preſerved.

The defect of this proceſs evidently is, that it is a petty operation, which can only proceed ſlowly, and upon a diminutive ſcale. It is therefore unlikely to be adopted in the great operations of an extenſive agriculture, as a mode of preparing or preſerving human food.

Mr Forſyth's proceſs for converting roots into flour.

At the beginning of the year 1802, another proceſs for accompliſhing this important object was contrived by Robert Forſyth, Eſq. advocate. Of this proceſs, we are authorized to give the following account:

The

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The whole difficulty of diſcovering a proceſs, with the view to render ſucculent roots as eaſily preſerved and tranſported, and therefore in every reſpect as valuable as grain, ariſes from our not having the command of ſuch a degree of ſteady and vigorous, but moderate heat, as will deprive them of their moiſture, while at the ſame time they are prevented from being burnt or ſcorched in the way that coffee-beans are treated before being grinded. This requiſite degree of heat may be obtained in a very cheap and eaſy manner, by making uſe of the ſteam of boiling water, which never can burn any vegetable ſubſtance. Upon this principle, Mr Forſyth's proceſs is founded, and is conducted in the following manner:

1ſt, Let a quantity of potatoes, or carrots, or parſnips, &c. be waſhed, and then cut or chopped into very ſmall pieces.

2dly, Lay them upon a metallic plate, and dry them with the heat of ſteam tranſmitted through the metal. They are then in a ſtate analogous to grain, and ſeem capable of being preſerved for any length of time.

3dly, Reduce them into flour or meal, by grinding in any mill, or with any inſtrument capable of grinding grain.

The meal or flour thus prepared has no tendency to attract moiſture from the atmoſphere, and may be preſerved during any length of time, if cloſely preſſed or packed. Without this precaution, Mr Forſyth has preſerved it for twelve months, when it had been coarſely grinded in a coffee-mill.

The drying proceſs is not tedious. As potatoes contain a great quantity of ſtarch or gummy matter,

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the pieces of them, while drying, are apt to adhere to each other; they muſt therefore be frequently turned or ſtirred during that part of the operation. When dry, they are almoſt as hard as barley, and taſte ſomewhat like the ſkin of a roaſted potato.

Carrots and parſnips contain leſs gummy matter. They require leſs attention while drying, and do not become ſo hard. They may be grinded with eaſe. Their flour is very ſweet to the taſte. Its ſmell is fragrant, and though the taſte of the roots cannot be ſaid to be altered, it is rendered rich and agreeable by the concentration produced by the proceſs. This is more particularly the caſe with regard to the parſnips. Their meal, when coarſely grinded, and expoſed to the air for a month or two, loſes its grateful ſmell, but the taſte continues unchanged. The taſte is communicated very rapidly to lukewarm water, by pouring it upon the meal, ſo that it may probably prove of [illegible] value when ſubjected to the vinous fermentation; and it ſeems not improbable, that if ſugar is ever to be produced in abundance from plants of European growth, it muſt be by preparing them according to this proceſs.

Mr Forſyth performed his experiments with a ſteam apparatus, which, with ſome alterations, may prove not unſuitable, when erected upon a great ſcale.

Mr Forſyth's ſteam apparatus.

A, Plate XIII. fig. 5. a ſhallow veſſel of tinned plate, commonly called *white iron*, one foot ſquare, and two inches in depth, for containing ſubſtances to be dried.

B, a ſmall round veſſel, in which water is kept boiling by a lamp, C, with three wicks.

D, a tube, by which the ſteam paſſes into E, which contains

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contains the drying veſſel A, and is cloſely ſoldered all round to the bottom of it.

F, a tube, by which the water formed by the condenſed ſteam, flows from the ſteam veſſel, E, back into the boiler B, entering at the bottom of the boiler.

G, a crooked tube, by which the ſuperfluous ſteam eſcapes into the open air. It is crooked, that it may retard the paſſage of the ſteam when the veſſel is at work, which forces it to depoſite more of its heat on the bottom of the drying veſſel A.

H, a tube by which the boiler B is filled with hot water.

I, a tube paſſing up through the centre of the boiler, and ſerving as a chimney to the lamp C. It does not communicate with the water in the boiler.

K ſhews the figure of the cover of the drying veſſel A. The cover has a groove or gutter LL, paſſing round its lower edge. The vapour which riſes from the roots when drying, condenſes on touching the cover, and flows down to the gutter, from which it eſcapes in the ſtate of water, by a hole left for that purpoſe at each corner. The cover is only uſed for the neatneſs requiſite in making experiments.

The whole is ſupported by four moveable feet, attached to the corners of the drying veſſel A, but not appearing in the figure. Every part of it is made of white iron or tinned plate.

Inſtead of the lamp C, a ſmall iron pan filled with pieces of burning charcoal, was ſometimes uſed to keep the water boiling, and a ſtill more convenient plan was at times adopted during the winter ſeaſon. It conſiſted of reſting the bottom of the boiler B, upon

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the front of the grate of the chamber, while a fire was burning, the reſt of the inſtrument being at the ſame time ſupported by a rope attached to the back of a chair, to a nail or peg in the wall for hanging a picture, or to any other convenient ſupport. When uſed in this laſt manner, however, the inſtrument has this defect, that the water in the tube H boils over at times into the fire, which might be avoided, by placing the tube on the oppoſite ſide of the boiler.

Upon the above contrivance it may be remarked, that a kiln formed of a large metallic plate, heated by the ſteam of boiling water, may prove valuable in many proceſſes. In particular, it will probably be found uſeful for drying malt, with a view to prevent the ale formed of it from having a brown colour. It may alſo, perhaps, be uſed with ſucceſs for drying wheat that is intended to be ſown, to prevent the future crop from ſuffering by mildew, as will be afterwards mentioned; and it affords a ready and cheap mode of drying not only roots, but all vegetable productions, without burning them, or altering their taſte or other eſſential properties.

SECT. II.

OF THE MOST PROPER KINDS OF VEGETABLES TO BE RAISED ROR THE PURPOSES OF FEEDING CATTLE.

THOUGH this muſt be an article of the utmoſt conſequence to every farmer, we do not find that it has been much conſidered. Dr Anderſon ſeems to have been the firſt writer on agriculture who has properly attended to this ſubject; and what he has wrote upon

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it, is rather a catalogue of deſiderata, than any thing elſe: and indeed the deſiderata on this ſubject are ſo many and ſo great, that we muſt acknowledge ourſelves very unable to fill them up.——To attain to a competent knowledge in this reſpect, the following things muſt be taken into conſideration. (1.) The wholeſomeneſs of the food for cattle, with regard to health and ſtrength, or fatneſs. (2.) The quantity that any extent of ground is capable of yielding. (3.) The quantity neceſſary to feed the different kinds of cattle. (4.) The labour of cultivation; and, (5.) The ſoil they require to bring them to perfection, and the effect they have upon it.

Qualities of the food requiſite for cattle.

With regard to the wholeſomeneſs, it is plain, that as the natural food of wild cattle is the green ſucculent plants they meet with all the year round, food of this kind, could it be had, muſt be preferable to hay; and accordingly we find that cattle will always prefer ſucculent vegetables where they can get them. To find plants of this kind, and having proper qualities in other reſpects, we muſt ſearch among thoſe which continue green all the year round, or come to their greateſt perfection in the winter time.—Of theſe, cabbages bid fair for holding the firſt place; both as being very ſucculent, and a very large quantity of them growing upon a ſmall ſpace of ground. In Mr Young's Six Months Tour, we have an account of the produce of cabbages in many different places, and on a variety of ſoils. The produce by Mr Crow at Keplin, on a clay ſoil, was, on an average of ſix years, 35 tons per acre; by Mr Smelt at the Leaſes, on a ſandy gravel, 18 tons per acre; by Mr Scroop at Danby, on an average of ſix years, 37 tons per acre: and the general average of

Cabbages, their properties.

of all the accounts given by Mr Young, is 36 tons per acre.

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Cabbages, however, have the great inconveniency of ſometimes imparting a diſagreeable flavour to the milk of cows fed with them, and even to the fleſh of other cattle. This, it is ſaid, may be prevented by carefully picking off the decayed and withered leaves: and very probably this is the caſe; for no vegetable inclines more to putrefaction than this; and therefore particular care ought to be taken to pull off all the leaves that have any ſymptoms of decay. Dr Prieſtley found that air was rendered noxious by a cabbage leaf remaining in it for one night, though the leaf did not ſhew any ſymptom of putrefaction.—For milch cows, probably, the cabbages might be rendered more proper food by boiling them.

Air rendered noxious by them.

The culture of the turnip-rooted cabbage has lately been much practiſed, and greatly recommended, particularly for the purpoſe of a late ſpring feed; and ſeems indeed to be a moſt important article in the farming economy, as will be ſhown in its proper place.

Turnip-rooted cabbage.

Turnips likewiſe produce very bulky crops, though far inferior to thoſe of cabbages. According to Mr Young's calculations, the fineſt ſoil does not produce above five tons of turnips per acre. In this reſpect, however, great varieties occur, as will be afterwards mentioned; and turnips poſſeſs the advantage of flouriſhing upon a poorer ſoil than cabbages.

Turnips.

Carrots are found to be an excellent food for cattle of all kinds, and are greatly reliſhed by them. In a rich ſand, according to Mr Young's account, the produce of this root was 200 buſhels per acre. In a finer ſoil,

Carrots.

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ſoil, it was 640 buſhels per acre. A lean hog was fatted by carrots in ten days time: he ate 196 lb.; and his fat was very fine, white, firm, and did not boil away in the dreſſing. They were preferred to turnips by the cattle; which, having taſted the carrots, ſoon became ſo fond of them, as with difficulty to be made to eat the turnips at all. It is probable, indeed, that carrots will make a more wholeſome food for cattle than either cabbages or turnips, as they are ſtrongly antiſeptic; inſomuch as to be uſed in poultices for correcting the ſanies of ulcers. It is probably owing to this, that the milk of cows fed on carrots is never found to have any bad taſte. Six horſes kept on them through the winter, without oats, performed their work as uſual, and looked equally well. This may be looked upon as a proof of their ſalubrity as a food; and it certainly can be no detriment to a farmer to be ſo much verſant in medical matters, as to know the impropriety of giving putreſcent food to his cattle. It is well known what a prodigious difference there is in the health of the human ſpecies when fed on putrid meats, in compariſon of what they enjoy when ſupplied with food of a contrary nature; and why may there not be a difference in the health of beaſts, as well as of men, when in ſimilar circumſtances?—It is alſo very probable, that as carrots are more ſolid than cabbages or turnips, they will go much farther in feeding cattle than either of them. The above-mentioned example of the hog ſeems ſome kind of confirmation of this: he being fed, for ten days together, with 21lb. leſs weight of carrots, than what an ox devoured of cabbages and hay in one day. There is a great diſproportion, it muſt be owned, between the bulk of an ox and that of a hog; but we can ſcarce think that an ox will eat as much at a time as ten hogs. At Parlington in Yorkſhire, 20 work horſes, four bullocks, and ſix milch cows, were fed on the carrots that grew on three acres, from the end of September till the beginning of May; and the animals never taſted any other food but a little hay. The milk was excellent, and 30 hogs were fattened upon what was left by the cattle.

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Potatoes likewiſe appear to be a very palatable food for all kinds of cattle; and not only oxen, hogs, &c. are eaſily fed by means of them, but even poultry. According to a correſpondent of the Bath Society *, " roaſting pork is never ſo moiſt and delicate as when fed with potatoes, and killed from the barn doors without any confinement. For bacon and hams, two buſhels of pea-meal ſhould be well incorporated with four buſhels of boiled potatoes, which quantity will fat a hog of twelve ſtone (fourteen pounds to the ſtone). Cows are particularly fond of them: half a buſhel at night, and the ſame proportion in the morning, with a ſmall quantity of hay, is ſufficient to keep three cows in full milk; they will yield as much and as ſweet butter as the beſt graſs. In fattening cattle, I allow them all they will eat: a beaſt of about 35 ſtone will require a buſhel per day, but will fatten one-third ſooner than on turnips. The potatoes ſhould be clean waſhed, and not given until they are dry. They do not require boiling for any purpoſe but fattening hogs for bacon, or poultry; the latter eat them greedily. I prefer the champion potato to any ſort I ever cultivated. They do not anſwer ſo well for horſes and

Potatoes.

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* *Letters* and *Papers* on *Agriculture*, &c. vol. iii. art. 16.

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and colts as I expected (at leaſt they have not with me), though ſome other gentlemen have approved of them as ſubſtitutes for oats."

The above-mentioned vegetables have all of them the property of pulverizing or ſoftening the ſoil; and this is certainly a very valuable qualification: but carrots and cabbages will not thrive except in ſoils that are already well cultivated; while potatoes and turnips may be uſed as the firſt crops of a ſoil with great advantage. In this reſpect, they are greatly ſuperior to the others, on account of the encouragement which they give to the cultivation of waſte lands.

Buck-wheat.

Buck-wheat (*Polygonum fagopyrum*) has been lately recommended as an uſeful article in the preſent as well as other reſpects. It has been chiefly applied to the feeding of hogs, and eſteemed equal in value to barley; it is much more eaſily ground than barley, as a malt-mill will grind it completely. Horſes are very fond of the grain; poultry of all ſorts are ſpeedily fattened by it; and the bloſſom of the plant affords food for bees at a very opportune ſeaſon of the year, when the meadows and trees are moſtly ſtripped of their flowers. Probably the grain may hereafter be even found a material article in diſtillation, ſhould a ſufficient quantity be raiſed with that view. From the ſucceſs of ſome experiments detailed in the Bath Society Papers, and for which a premium was beſtowed, it has been inferred, that this article ought in numerous caſes to ſuperſede the practice of ſummer-fallowing.

Whins an excellent food for horſes.

Whins have lately been recommended as very proper food for cattle, eſpecially horſes; and are recommended by Dr Anderſon in a particular manner. They have this advantage, that they require no culture, and grow

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grow on the very worſt ſoil; but they are troubleſome to cut, and require to be bruiſed in a mill conſtructed for this purpoſe; neither is the ground at all meliorated by letting whins grow upon it for any length of time. Notwithſtanding theſe diſadvantages, however, as whins continue green all the year round, and when bruiſed will afford an excellent ſucculent food, which ſeems poſſeſſed of ſtrongly invigorating qualities, they may be looked upon as the cheapeſt winter food that can poſſibly be given to cattle.—According to the calculations of Mr Eddiſon of Gateford, a ſingle acre, well cropped with whins, will winter ſix horſes. At three or four years growth, the whole crop ſhould be taken, cut cloſe to the ground, and carried to the mill, in which the whins are to be bruiſed, and then given to the horſes. Four acres ought to be planted, that one may be uſed each year, at the proper age to be cut; and he reckons the labour of one man ſufficient for providing food to this number of horſes He ſays they all prefer the whins to hay, or even to corn.

Burnet.

The herb called *burnet* has likewiſe been recommended as proper food for cattle, on account of its being an evergreen; and further recommended, by growing almoſt as faſt in winter as in ſummer. Of this herb, however, we have very various accounts. In a letter addreſſed by Sir James Caldwell, F. R. S. to the Dublin Society, the culture of this plant is ſtrongly recommended, on the authority of one Bartholomew Rocque, farmer at Walham-Green, a village about three miles ſouth-weſt of London.

Recommended by Sir James Caldwell.

What gave occaſion to the recommendation of this plant, was, that about the year 1760, Mr Wych, chairman of the committee of Agriculture of the London

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Society for the encouragement of arts, manufactures, and commerce, came to Rocque (who was become very eminent by the premiums he had received from the ſociety), and told him, he had been thinking, that as there are many animals which ſubſiſt wholly upon the fruits of the earth, there muſt certainly be ſome plant or herb fit for them that naturally vegetates in winter; otherwiſe we muſt believe the Creator, infinitely wiſe and good, to have made creatures without providing for their ſubſiſtence; and that if there had been no ſuch plants or herbs, many ſpecies of animals would have periſhed before we took them out of the hands of nature, and provided for them dry meat at a ſeaſon, when, indigenous plants having been indiſcriminately excluded, under the name of weeds, from cultivated fields and places ſet apart for natural graſs, green or freſh meat was no longer to be found.

Rocque allowed the force of this reaſoning; but ſaid, the knowledge of a graſs, or artificial paſture, that would vegetate in winter, and produce green fodder for cattle, was loſt; at leaſt, that he knew of no ſuch plant.—Mr Wych, however, knowing how very great the advantage would be of diſcovering a green fodder for winter and early in the ſpring, wrote to Bern, and alſo to ſome conſiderable places in Sweden, ſtating the ſame argument, and aſking the ſame queſtion. His anſwers to theſe letters were the ſame that had been given by Rocque. They owned there muſt be ſuch plant, but declared they did not know it.

Mr Wych then applied again to Rocque; and deſired him to ſearch for the plant ſo much deſired, and ſo certainly exiſting. Rocque ſet about this ſearch with great aſſiduity; and finding that a pimpernel, called

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called *burnet*, was of very ſpeedy growth, and grew nearly as faſt in winter as in ſummer, he took a handful of it and carried it into his ſtable, where there were five horſes; every one of which ate of it with the greateſt eagerneſs, ſnatching it even without firſt ſmelling it. Upon the ſucceſs of this experiment he went to London, and bought all the burnet ſeed he could get, amounting to no more than eight pounds, it having been only uſed in ſalads; and he paid for it at the rate of 4s. a-pound. Six of the eight pounds of ſeed he ſowed upon half an acre of ground, in March, in the year 1761, with a quarter of a peck of ſpring wheat, both by hand. The ſeed being very bad, it came up but thin. However, he ſowed the other two pounds in the beginning of June, upon about ſix roods of ground: this he mowed in the beginning of Auguſt; and at Michaelmas he planted off the plants on about 20 rood of ground, giving each plant a foot every way, and taking care not to bury the heart. Theſe plants bore two crops of ſeed the year following; the firſt about the middle of June, the ſecond about the middle of September; but the June crop was the beſt. The year after, it grew very rank and produced two crops of ſeed; both very good. As it ought not to be cut after September, he let it ſtand till the next year; when it ſheltered itſelf, and grew very well during all the winter, except when there was a hard froſt; and even during the froſt it continued green, though it was not perceived to grow. In the March following it covered the ground very well, and was fit to receive cattle.

If the winter is not remarkably ſevere, the burnet, though cut in September, will be 18 inches long in March;

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March; and it may be fed from the beginning of February till May: if the cattle are taken off in May, there will be a good crop of ſeed in the beginning of July. Five weeks after the cattle are taken off, it may be removed, if that is preferred to its ſtanding for ſeed. It grows at the rate of an inch a-day, and is made into hay like other graſs. It may be mown three times in one ſummer, and ſhould be cut juſt before it begins to flower. Six rood of ground has produced 1150 pounds at the firſt cutting of the third year after it was ſowed; and, in autumn 1763, Rocque ſold no leſs than 300 buſhels of the ſeed.

According to Rocque, the ſoil in which burnet flouriſhes beſt, is a dry gravel; the longeſt drought never hurts it: and Sir James Caldwell aſſerts, that he ſaw a very vigorous and exuberant plant of this kind, growing from between two bricks in a wall in Rocque's ground, without any communication with the ſoil; for he had cut away all the fibres of the root that had ſtretched downward, and penetrated the earth, long before.

Burnet was found equally fit for feeding cows, ſheep, and horſes; but the ſheep muſt not be ſuffered to crop it too cloſe. Though no ſeed was left among the hay, yet it proved nouriſhing food; and Rocque kept a horſe upon nothing elſe, who, at the time of writing the account, was in good heart, and looked well. He affirmed alſo, that it cured horſes of the diſtemper called the *greaſe*, and that by its means he cured one which was thought incurable; but ſays, it is only the firſt crop which has this effect.

Burnet reckoned an improper food by Mr Miller and Mr Anderſon.

This is the ſubſtance of Sir James Caldwell's letter to the Dublin Society, at leaſt as to what regards the culture of burnet; and it might reaſonably be expected,

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ed, that a plant, whoſe uſe was recommended to the public with ſo much parade, would ſoon have come into univerſal eſteem. We were ſurpriſed, therefore, on looking into Mr Miller's Dictionary, to find the following words, under the article *Poterium*:—"This plant has of late been recommended by *perſons of little ſkill*, to be ſown as a winter pabulum for cattle: but whoever will give themſelves the trouble to examine the grounds where it naturally grows will find the plants left uneaten by the cattle, when the graſs about them has been cropped to the roots; beſides, in wet winters, and in ſtrong land, the plants are of ſhort duration, and therefore very unfit for that purpoſe; nor is the produce ſufficient to tempt any perſon of ſkill to engage in its culture; therefore I wiſh thoſe perſons to make trial of it in ſmall quantities, before they embark largely in theſe new ſchemes."—Dr Anderſon, too, in his Eſſays on Agriculture, mentions the produce of burnet being ſo ſmall, as not to be worth cultivating.

White beet recommended.

Upon the authority of Mr Rocque, likewiſe, the white beet is recommended as a moſt excellent food for cows; that it vegetates during the whole winter, conſequently is very forward in the ſpring; and that the moſt profitable way of feeding cows is to mow this herb, and give it to them green all the ſummer. It grew in Rocque's garden, during a very great drought, no leſs than four feet high, from the 30th of May to the 3d of July; which is no more than one month and four days. In ſummer it grows more than an inch a-day; and is beſt ſown in March: a buſhel is enough for an acre, and will not coſt more than ten ſhillings. It thrives beſt in a rich, deep, light ſoil: the ſtalks

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are very thick and ſucculent; the cows ſhould therefore eat them green.

Root of Scarcity.

Another ſpecies of beet (*Beta cicla*), the Mangel Wurzel, or *Root of Scarcity*, as it has been called, has been lately extolled as food both for man and cattle; but, after all, ſeems only to deſerve attention in the latter view. It is a biennial plant; the root is large and fleſhy, ſometimes a foot in diameter. It riſes above the ground ſeveral inches, is thickeſt at the top, tapering gradually downward. The roots are of various colours, white, yellow, and red; but theſe laſt are always of a much paler colour than beetrave. It is good fodder for cows, and does not communicate any taſte to the milk. It produces great abundance of leaves in ſummer, which may be cut three or four times without injuring the plant. The leaves are more palatable to cattle than moſt other garden plants, and are found to be very wholeſome. The farmers in thoſe parts of Germany where it is chiefly cultivated, we are told, prefer this ſpecies of beet, for feeding cattle, to cabbages, principally becauſe they are not ſo liable to be hurt by worms or inſects; but they think they are not ſo nouriſhing as turnips, potatoes, or carrots, and that cattle are not nearly ſo ſoon fattened by this root as by carrots, parſnips, or cabbages. It has even been aſſerted, that this root affords leſs nouriſhment than any of thoſe that have been commonly employed for feeding cattle. This does not correſpond with the pompous accounts with which the public has been entertained. Upon the whole, however, it is a plant which ſeems to deſerve the attention of our farmers; as on ſome ſoils, and in particular circumſtances, it may prove a very uſeful article for the above purpoſes.

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Sheep's feſcue graſs.

In Dr Anderſon's Eſſays, we find it recommended to make trial of ſome kinds of graſſes, which probably would not only anſwer for freſh fodder during the winter, but might alſo be cut for hay in ſummer. This is particularly the caſe with that ſpecies called *Sheep's feſcue graſs*. "I had, ſays he, a ſmall patch of this graſs in winter 1773; which, having been cut in the month of Auguſt or September preceding, was ſaved from that period, and had advanced before winter to the length of five or ſix inches; forming the cloſeſt pile that could be imagined. And although we had about ſix weeks of very intenſe froſt, with ſnow, and about other ſix weeks, immediately ſucceeding that, of exceeding keen froſt every night, with frequent thaws in the day time, without any ſnow, during which time almoſt every green thing was deſtroyed; yet this little patch continued all along to retain as fine a verdure as any meadow in the month of May; hardly a point of a leaf having been withered by the uncommon ſeverity of the weather. And as this graſs begins to vegetate very early in the ſpring, I leave the reader to judge what might be the value of a field of graſs of this kind in theſe circumſtances."

Purple feſcue.

Of another kind of graſs, called *purple feſcue*, Dr Anderſon gives the following character: "It retained its verdure much better than rye-graſs during the winter ſeaſon; but it had more of its points killed by the weather than the former. It likewiſe riſes in the ſpring, at leaſt as early as rye-graſs."

This ingenious farmer, and well-known author, has alſo made experiments on the culture of theſe and ſeveral other kinds of graſſes.

In every branch of ſcience actual experiment is the only

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only means by which any real or permanent improvement can be made. It is in conſequence of a conviction of this truth, and of the active induſtry which has reſulted from that conviction, that phyſical ſcience has made ſuch rapid improvements in modern times. *Every experiment in the art of agriculture, when made with rational views, and reported with candour, is entitled to an uncommon degree of attention.* It is not only, as in other branches of ſcience, the only mode in which knowledge or improvement can be ſucceſsfully purſued, but the perſon who engages in it uſually poſſeſſes more merit than the contriver of other phyſical experiments, on account of the patient obſervation which he is under the neceſſity of exerting, in conſequence of the length of time which muſt elapſe before his trials can be rendered complete. The importance of the ſubject alſo entitles it to particular regard. We have every reaſon to believe that valuable plants will ſtill be diſcovered, the uſe of which will give additional fertility to the earth, and additional reſources for the ſupport of the animals by which it is inhabited. It is certain at leaſt that the perſon who introduced into any country the uſe of the turnip or potato plant, performed a more valuable ſervice to its inhabitants, than if he had realized for them the imaginary art of the tranſmutation of all the metals into gold. We account it unneceſſary, therefore, to make any apology for inſerting here Dr Anderſon's experiments upon ſeveral kinds of our native graſſes, as, in another part of our work, we ſhall have occaſion to ſtate other experiments upon the ſame ſubject, which have been made by intelligent cultivators.

1. *Purple feſcue graſs.* "Although this graſs is very often found in old paſtures, yet, as it has but few flower-

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ſtalks, and as it is greedily eaten by all domeſtic animals, theſe are ſeldom ſuffered to appear; ſo that it uſually remains there unperceived. But it ſeems to be better able to endure the peculiar acrimony of the dung of dogs than almoſt any other plant; and is, therefore, often to be met with in *dog-hills*, as I call *the little hills by road ſides where dogs uſually piſs and dung*: and as it is allowed to grow there undiſturbed, the farmer may have an opportunity of examining the plant, and becoming acquainted with its appearance.

"The leaves are long and ſmall, and appear to be roundiſh, ſomething like a wire; but, upon examination, they are found not to be tubulated like a reed or ruſh; the ſides of the leaf being only folded together from the middle rib, exactly like the ſtrong bent-graſs on the ſea ſhore. The flower-ſtalk is ſmall, and branches out in the head, a little reſembling the wild oat; only the grains are much ſmaller, and the ear does not ſpread full open, but lies bending a little to one ſide. The ſtalks are often ſpotted with reddiſh freckles, and the tops of the roots are uſually tinged with the ſame colour; from whence it has probably obtained its diſtinctive name of *feſtuca rubra*, or *red (purple) feſcue*.

"It is often to be met with in old garden walks; and, as its leaves advance very quickly after cutting, it may uſually be diſcovered above the other graſſes, about a week or a fortnight after the walks are cut. Nor do they ſeem to advance only at one ſeaſon, and then ſtop and decay, like the rye-graſs; but continue to advance during the whole of the ſummer, even where they are not cut; ſo that they ſometimes at-

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tain a very great length. Laſt ſeaſon (1774), I meaſured a leaf of this graſs, that ſprung up in a neglected corner, which was four feet and four inches in length, although not thicker than a ſmall wire. It is unneceſſary to add, that theſe leaves naturally trail upon the ground, unleſs where they meet with ſome accidental ſupport; and, that if any quantity of it is ſuffered to grow for a whole ſeaſon, without being eaten down or cut, the roots of the leaves are almoſt rotted, by the overſhadowing of the tops of the other leaves, before the end of the ſeaſon.

Appearance in its cultivated ſtate.

"This is the appearance and condition of the plant in its native ſituation: as it is ſeldom that it is diſcovered but in pretty old paſtures, and, as in that ſtate it carries only a very few ſeed-ſtalks, it was with ſome difficulty that I could collect a ſmall handful of the ſeed, which I carefully ſowed in a ſmall patch of garden mould, to try if it could be eaſily cultivated. It came up as quickly as any other kind of graſs, but was at firſt as ſmall as hairs; the leaves, however, advanced apace; and were, before autumn, when the grain with which they had been ſowed was cut down, about 16 or 18 inches in length; but having been ſown very thin, it was neceſſary to pick out ſome other kinds of graſs that came up amongſt it, leſt it might have been choked by them. Early the next ſpring it advanced with prodigious vigour, and the tufts that were formed from every ſeed became exceeding large; ſo that it quickly filled the whole ground. But now the leaves were almoſt as broad as thoſe of common rye-graſs, and the two ſides only inclined a little towards one another from the mid-rib, without any appearance of roundneſs. In due time a great many ſeed-ſtalks ſprung out, which

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attained very nearly to the height of four feet, and produced ſeeds in abundance; which may be as eaſily ſaved as thoſe of common rye-graſs.

"*The prodigious difference between this plant in its native and cultivated ſtate amazed me*; but *it was with a good deal of ſatisfaction that I found there would be no difficulty in procuring ſeeds from it, which I had much doubted of at firſt.* It would ſeem, that nature hath endowed this plant with a ſtrong generative power, during its youth, which it gradually loſes as it advances in age (for the difference perceived in this caſe could not be attributed to the richneſs of the ſoil); and that, on the contrary, when it was old, the leaves advanced with an additional vigour, in proportion to the declining ſtrength of the flower-ſtalks: for the leaves of the young plants ſeldom exceed two feet, whereas numbers of the old leaves were near four feet in length.

"From theſe peculiarities in the growth of this plant, it would ſeem to promiſe to be of great uſe to the farmer; as he could reap from a field of it, for the firſt two or three years, as great a weight of hay as he could obtain from any of the culmiferous graſſes (thoſe bearing a long jointed ſtalk); and, if he meant afterwards to paſture it, he would ſuffer no inconveniences from the flower-ſtalks; and the ſucculent leaves that continue to vegetate during the whole ſummer, would at all times furniſh his cattle with abundance of wholeſome food. It has alſo been remarked, that this graſs riſes as early in the ſpring as rye-graſs; and continues green for the greateſt part of winter, which the other does not. It is moreover an abiding plant, as it ſeems never to wear out of the ground where it has once

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been eſtabliſhed. On all which accounts, it appears to me highly to merit the attention of the farmer; and well deſerves to have its ſeveral qualities, and the culture that beſt agrees with it, aſcertained by accurate experiments.

Sheep's feſcue deſcribed.

2. " *Sheep's feſcue graſs*, or *feſtuca ovina*, is much praiſed by the Swediſh naturaliſts for its ſingular value as a paſture-graſs for ſheep; this animal being repreſented as fonder of it than of any other graſs, and fattening upon it more quickly than on any other kind of food whatever. And indeed, the general appearance of the plant, and its peculiar manner of growth, ſeem very much to favour the accounts that have been given us of it.

" This plant is of the ſame family with the former, and agrees with it in ſeveral reſpects; although they may be eaſily diſtinguiſhed from one another. Its leaves, like the former, in its natural ſtate, are always rounded, but much ſmaller; being little bigger than large horſe hairs, or ſwine-briſtles, and ſeldom exceed ſix or ſeven inches in length. But theſe ſpring out of the root in tufts, ſo cloſe upon one another, that they reſemble, in this reſpect, a cloſe hair bruſh more than any thing elſe I know: ſo that it would ſeem naturally adapted to form that thick ſhort pile of graſs in which ſheep are known chiefly to delight. Its flower-ſtalks are numerous, and ſometimes attain the height of two feet; but are more uſually about 12 or 15 inches high.

Its appearance when cultivated.

" Upon gathering the ſeeds of this plant, and ſowing them as the former, it was found that they ſprung up as quickly as any other kind of graſs; but the leaves are at firſt no bigger than a human hair. From each ſide ſprings up one or two of theſe hair-like filaments, that, in a ſhort time, ſends out new offsets, ſo as quickly to form a ſort of tuft, which grows larger and larger, till it at length attains a very large ſize, or till all the intervals are cloſed up, and then it forms the cloſeſt pile of graſs that it is poſſible to imagine. In April and May it puſhed forth an innumerable quantity of flower-ſtalks, that afforded an immenſe quantity of hay; it being ſo cloſe throughout, that the ſcythe could ſcarcely penetrate it. This was allowed to ſtand till the ſeeds ripened; but the bottoms of the ſtalks were quite blanched, and almoſt rotted for want of air before that time.

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" This was the appearance that it made the firſt year after it was ſowed: but I have reaſon to think, that, after a few years, it likewiſe produces fewer ſeed-ſtalks, and a greater quantity of leaves, than at firſt. But, however that may be, it is certain, that if theſe are eaten down in the ſpring, it does not, like rye-graſs, perſiſt in a continued tendency to run to ſeed; but is at once determined to puſh forth a quantity of leaves without almoſt any ſtalks at all: and, as all domeſtic animals, but more eſpecially ſheep, are extremely fond of this graſs, if they have liberty to paſture where it grows, they bite it ſo cloſe as never to ſuffer almoſt a ſingle ſeed-ſtalk to eſcape them; ſo that the botaniſt will often ſearch in vain for it, when he is treading upon it with his feet. The beſt way to diſcover it in any paſture, is to ſearch for it in winter, when the tufts of it may be eaſily diſtinguiſhed from every other kind of graſs, by their extraordinary cloſeneſs, and the deep green colour of the leaves.

" It ſeems to grow in almoſt any ſoil; although it is imagined

What ſoil moſt proper.

[illegible] food for Cattle.

imagined that it would flouriſh beſt in a light ſandy ſoil, as it can evidently live with leſs moiſture than almoſt any other kind of graſs; being often ſeen to remain in the ſods that have been employed in coping for ſtone dykes, after all the other graſſes that grew in them have diſappeared. It is likewiſe found in poor barren ſoils, *where hardly any other plant can be made to grow at all; and on the ſurface of dry worn-out peat moſs, where no moiſture remains ſufficient to ſupport any* other plant whatever: but in neither of theſe ſituations does it thrive; as it is there only a weak and unſightly plant, very unlike what it is when it has the good fortune to be eſtabliſhed upon a good ſoil; although it is ſeldomer met with in this laſt ſtate than in the former.

" I will not here repeat what has been already ſaid about the particular property that this plant poſſeſſes of continuing all winter; nor point out the benefits that the farmer may reap from this valuable quality.—He need not, however, expect to find any verdure in winter on ſuch plants as grow upon the looſe moſſy ſoil above mentioned; for, as the froſt in winter always hoves up the ſurface of this ſoil, the roots of the plants are ſo lacerated thereby, as to make it, for ſome time in the ſpring, to all appearance dead. Nor will he often perceive much verdure in winter upon thoſe plants that grow upon poor hungry ſoils, which cannot afford abundant nouriſhment to keep them in a proper ſtate of vegetation at all times: but ſuch plants as grow on earthen dykes, which uſually begin to vegetate with vigour when the autumnal rains come on, for the moſt part retain their verdure at that ſeaſon almoſt as well as if they were in good garden-mould.

"I have been very particular in regard to this plant; becauſe, in as far as my obſervations have yet gone, it promiſes, on many accounts, to make a moſt valuable acquiſition to the farmer, and therefore juſtly demands a very particular ſhare of his attention."

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Holcus lanatus.

3. The *holcus lanatus*, or creeping ſoft-graſs of Hudſon, commonly called *York* or *Yorkſhire white*.—This is conſidered by our author as one of the moſt valuable kinds of meadow-graſſes; its pile being exceedingly cloſe, ſoft, and ſucculent. It delights much in moiſture, and is ſeldom found on dry ground, unleſs the ſoil is exceeding rich. It is often found on thoſe patches near ſprings, over which the water frequently flows; and may be known by the uncommon ſoftneſs and ſucculence of the blade, the lively light green colour of the leaves, and the matted intexture of its roots. But, notwithſtanding the ſoftneſs of its firſt leaves, when the ſeed-ſtalks advance, they are rough to the touch, ſo that the plant then aſſumes a very different appearance from what we would have expected. The ear is branched out into a great number of fine ramifications, ſomewhat like the oat, but much ſmaller.—This kind of graſs, however, would not be eaſily cultivated; on account of a kind of ſoft membrane that makes the ſeeds adhere to the ſtalk, and to one another, after they are ſeparated from it, as if they were intermixed with cobweb, ſo that it is difficult to get them ſeparated from the ſtalk, or to ſpread readily in ſowing. It ſpreads, however, ſo faſt by its running roots, that a ſmall quantity ſowed very thin, would be ſufficient to ſtock a large field in a ſhort time.

Theſe are the kinds of *graſſes*, properly ſo called, which have not as yet been ſo generally cultivated as

they

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they ought to be; but which Dr Anderſon, at the time of writing his treatiſe, thought moſt likely to be of value. It is probable his recommendation has contributed not a little to procure attention to ſeveral of them; as it will afterwards appear, when we come to conſider the culture of graſſes, that they are now commonly ſown by the beſt agriculturiſts. Beſides theſe he recommends the following of the pea tribe.

Milk-vetch.

1. *Milk-vetch*, *liquorice-vetch*, or *milk-wort*. This plant, in ſome reſpects, very much reſembles the common white clover: from the top of the root a great number of ſhoots come out in the ſpring, ſpreading along the ſurface of the ground every way around it; from which ariſe a great many cluſters of bright yellow flowers, exactly reſembling thoſe of the common broom. Theſe are ſucceeded by hard round pods, filled with ſmall kidney-ſhaped ſeeds. From a ſuppoſed reſemblance of a cluſter of theſe pods to the fingers of an open hand, the plant has been ſometimes called *ladies-fingers*. By others it is called *crow-toes*, from a fancied reſemblance of the pods to the toes of a bird. Others, from the appearance of the bloſſom, and the part where the plant is found, have called it *feal*, improperly *fell-broom*. It is found plentifully almoſt everywhere in old graſs fields; but as every ſpecies of domeſtic animals eat it, almoſt in preference to any other plant, it is ſeldom allowed to come to the flower in paſture grounds, unleſs where they have been accidentally ſaved from the cattle for ſome time; ſo that it is only about the borders of corn fields, or the ſides of incloſures to which cattle have not acceſs, that we have an opportunity of obſerving it. As it has been imagined that the cows which feed on the paſtures where this

plant

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plant abounds, yield a quantity of rich milk, the plant has, from that circumſtance, obtained its moſt proper Engliſh name of *milk-vetch*.

Its good qualities.

One of the greateſt recommendations of this plant is, that it grows in poor barren ground, where almoſt no other plant can live. It has been obſerved in ground ſo poor, that even heath, or ling *(erica communis)*, would ſcarcely grow; and upon bare obdurate clays, where no other plant could be made to vegetate, inſomuch that the ſurface remained entirely uncovered, unleſs where a plant of this kind chanced to be eſtabliſhed; yet, even in theſe unfavourable circumſtances, it flouriſhed with an uncommon degree of luxuriance, and yielded as tender and ſucculent, though not ſuch abundant ſhoots, as if reared in the richeſt manured fields. In dry barren ſands, alſo, where almoſt no other plant could be made to live, it has been found to ſend out ſuch a number of healthy ſhoots all round, as to cover the earth with the cloſeſt and moſt beautiful carpet that can be deſired.

The ſtalks of the milk-vetch are weak and ſlender, ſo that they ſpread upon the ſurface of the ground, unleſs they are ſupported by ſome other vegetable. In ordinary ſoils they do not grow to a great length, nor produce many flowers; but in richer fields the ſtalks grow to a much greater length, branch out a good deal, but carry few or no flowers or ſeeds. From theſe qualities our author did not attempt at firſt to cultivate it with any other view than that of paſture; and, with this intention, ſowed it with his ordinary hay ſeeds, expecting no material benefit from it till he deſiſted from cutting his field. In this, however, he was agreeably diſappointed; the milk-vetch growing the

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firſt ſeaſon as tall as his great clover, and forming exceeding fine hay; being ſcarce diſtinguiſhable from lucerne, but by the ſlenderneſs of the ſtalk, and proportional ſmallneſs of the leaf.

Another recommendation of this plant is, that it is perennial. It is ſeveral years after it is ſowed before it attains to its full perfection; but, when once eſtabliſhed, it probably remains for a great number of years in full vigour, and produces annually a great quantity of fodder. In autumn 1773, Dr Anderſon cut the ſtalk from an old plant that grew on a very indifferent ſoil; and, after having thoroughly dried it, he found that it weighed 14 ounces and a half.

The ſtalks of this plant die down entirely in winter, and do not come up in the ſpring till the ſame time that clover begins to advance; nor does it advance very faſt, even in ſummer, when once cut down or eaten over: ſo that it ſeems much inferior to the above-mentioned graſſes; but might be of uſe to cover the worſt parts of a farm, on which no other vegetable could thrive.

Yellow vetchling.

2. The *common yellow vetchling* (*Lathyrus pratenſis*), or *everlaſting tare*, grows with great luxuriance in ſtiff clay ſoils, and continues to yield annually a great weight of fodder, of the very beſt quality, for any length of time. This is equally fit for paſture or hay; and grows with equal vigour in the end of ſummer as in the beginning of it; ſo would admit being paſtured upon in the ſpring, till the middle, or even the end of May, without endangering the loſs of the crop of hay. This is an advantage which no other plant except clover poſſeſſes; but clover is equally unfit for early paſture or for hay. Sainfoin is the only plant whoſe qualities approach

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proach to it in this reſpect, and the yellow vetchling will grow in ſuch ſoils as are utterly unfit for producing ſainfoin.—It is alſo a perennial plant, and increaſes ſo faſt by its running roots, that a ſmall quantity of the ſeed would produce a ſufficient number of plants to fill a whole field in a very ſhort time. If a ſmall patch of good ground is ſowed with the ſeeds of this plant in rows, about a foot diſtance from one another, and the intervals kept clear of weeds for that ſeaſon, the roots will ſpread ſo much as to fill up the whole patch next year; when the ſtalks may be cut for green fodder or hay. And if that patch were dug over in the ſpring following, and the roots taken out, it would furniſh a great quantity of plants, which might be planted at two or three feet diſtance from one another, where they would probably overſpread the whole field in a ſhort time.

Blue tare.

3. The *common blue tare* ſeems more likely than the former to produce a more flouriſhing kind of hay, as it abounds much more in ſeeds; but as the ſtalks come up more thinly from the root, and branch more above, it does not appear to be ſo well adapted for a paſture graſs as the other. The leaves of this plant are much ſmaller, and more divided, than thoſe of the other; the ſtalks are likewiſe ſmaller, and grow to a much greater length. Though it produces a great quantity of ſeeds, yet the ſmall birds are ſo fond of them, that, unleſs the field were carefully guarded, few of them would be allowed to ripen.

Buſh-vetch.

4. The *vicia ſepium; purple, everlaſting,* or *buſh-vetch.* Our author gives the preference to this plant beyond all others of the ſame tribe for paſture. The roots of it ſpread on every ſide a little below the ſurface of the ground,

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ground, from which, in the ſpring, many ſtems ariſe quite cloſe by one another; and as theſe have a broad tufted top covered with many leaves, it forms as cloſe a pile as could be deſired. It grows very quickly after being cut or cropt, but does not arrive at any great height; ſo that it ſeems more propet for paſturage than making hay; although, upon a good ſoil, it will grow ſufficiently high for that purpoſe; but the ſtalks grow ſo cloſe upon one another, that there is great danger of having it rotted at the root, if the ſeaſon ſhould prove damp. It ſeems to thrive beſt in a clay ſoil.

Everlaſting pea.

Beſides theſe, there are a variety of others of the ſame claſs, which he thinks might be uſeful to the farmer. The common garden everlaſting pea, cultivated as a flowering plant, he conjectures, would yield a prodigious weight of hay upon an acre; as it grows to the height of ten or twelve feet, having very ſtrong ſtalks, that could ſupport themſelves without rotting till they attained a great height.

Achillea millefolium.

One other plant, before unnoticed, is recommended by our author to the attention of the farmer; it is the *common yarrow (Achillea millefolium)*, or *hundred-leaved graſs*. Concerning this plant, he remarks, that in almoſt every fine old paſture, a great proportion of the growing vegetables with which the field is covered conſiſts of it; but the animals which feed there are ſo fond of the yarrow, as never to allow one ſeed-ſtalk of it to come to perfection. Hence theſe ſeed-ſtalks are never found but in neglected corners, or by the ſides of roads; and are ſo diſagreeable to cattle, that they are never taſted; and thus it has been erroneouſly thought that the whole plant was refuſed by them.—The leaves of this plant have a great tendency to grow very thick

upon

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upon one another, and are therefore particularly adapted for paſturage. It arrives at its greateſt perfection in rich fields that are naturally fit for producing a large and ſucculent crop of graſs. It grows alſo upon clays; and is among the firſt plants that ſtrike root in any barren clay that has been lately dug from any conſiderable depth; ſo that this plant, and thiſtles, are uſually the firſt that appear on the banks of deep ditches formed in a clayey ſoil. All animals delight to eat it; but, from the dry aromatic taſte it poſſeſſes, it would ſeem peculiarly favourable to the conſtitution of ſheep. It ſeems altogether unfit for hay.

Lucerne.

Beſides theſe plants, which are natives of our own country, there are others which, though natives of a foreign climate, are found to thrive very well in Britain; and have been raiſed with ſuch ſucceſs by individuals, as highly to merit the attention of every farmer. Among them the firſt place is claimed by lucerne.

This is the plant called *medica* by the ancients, becauſe it came originally from Media, and on the culture of which they beſtowed ſuch great care and pains. It has a perennial root, and annual ſtalks, which, in a good ſoil, riſe to three feet, or ſometimes more, in height; its leaves grow at a joint like thoſe of clover; the flowers, which appear in June, are purple; and its pods are of a ſcrew-like ſhape, containing ſeeds which ripen in September. All ſorts of domeſtic cattle are fond of this plant, eſpecially when allowed to eat it green, and black cattle may be fed very well with the hay made from it; but an exceſs of this food is ſaid to be very dangerous.

Lucerne has the property of growing very quickly after

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after it is cut down, inſomuch that Mr Rocque has mowed it five times in a ſeaſon, and Dr Anderſon affirms he has cut it no leſs than ſix times. It is, however, not very eaſily cultivated; in conſequence of which it ſometimes does not ſucceed.

Timothy graſs.

Another graſs was brought from Virginia, where it is a native, and ſown by Rocque in 1763. This graſs is called *timothy*, from its being brought from New-York to Carolina by one Timothy Hanſon. It grows beſt in a wet ſoil; but will thrive in almoſt any. If it is ſown in Auguſt, it will be fit for cutting in the latter end of May or beginning of June. Horſes are very fond of it, and will leave lucerne to eat it. It is alſo preferred by black cattle and ſheep; for a ſquare piece of land having been divided into four equal parts, and one part ſowed with lucerne, another with ſainfoin, a third with clover, and the fourth with timothy, ſome horſes, black cattle, and ſheep, were turned into it, when the plants were all in a condition for paſturage; and the timothy was eaten quite bare, before the clover, lucerne, or ſainfoin, were touched.

One valuable property of this graſs is, that its roots are ſo ſtrong and interwoven with one another, that they render the wetteſt and ſofteſt land, on which a horſe could not find footing, firm enough to bear the heavieſt cart. With the view of improving boggy lands, therefore, ſo as to prevent their being poached with the feet of cattle, Dr Anderſon recommends the cultivation of this kind of graſs, from which he has little expectation in other reſpects.

Grazing compared with the plough.

On this ſubject, of the kind of plants moſt proper to be raiſed for feeding cattle, one general queſtion ought not to paſs unnoticed concerning the propriety of feed-

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ing them upon roots and plants cultivated by the aid *of the plough, or upon leaving them to derive their ſubſiſtence from lands allowed to remain continually in paſturage.* The advantages of the latter practice are ſet forth by Thomas Davis, Eſq. of Longleet, in the following words *. "Experience ſufficiently evinces the extreme difficulty of perſuading tenants that they get more (generally ſpeaking) by feeding their lands, than by ploughing them; yet it requires very few arguments to convince a landlord, that, in cold wet land eſpecially, the leſs ploughed land you have, the leſs you put it in the tenant's power to ruin your eſtate. That a tenant of 60l. per annum on a dairy farm will get money, while a corn farm of the ſame ſize will ſtarve its occupier (though perhaps the former gives 15s. per acre for his land, and the latter only 10s.), is ſelf-evident. The plough is a friend of everybody's, though its advantages are very far from being particularly and locally felt; corn being an article that will bear keeping till the whim or caprice, or ſuppoſed advantage of its poſſeſſor, call it forth. But the produce of the cow is far otherwiſe. Cheeſe muſt neceſſarily be ſold at a certain period: it is a ponderous article; and one-twelfth, or at leaſt one-fifteenth of its value, is often paid for carrying it to a fair 50 miles off; and the butter and ſkimmed milk find their way no great diſtance from home, as is evident by the price of butter varying frequently one-third in 20 or 30 miles. Every inhabitant of Bath muſt be ſenſible, that butter and cheeſe have riſen one-third or more in price

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* *Bath Papers*, vol. iii.

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price within 20 years. Is not this owing to the great encouragement given to the plough and to grazing, at a time when, on account of the increaſed demand for milk, cream, butter, and cheeſe, every exertion on behalf of the dairy ſhould have been encouraged?" &c.

In ſome remarks on this letter by Mr Billingſley, the ſame ſuperiority of dairy farms to the arable kind is aſſerted in the moſt poſitive terms. "Perhaps (ſays he) there cannot be a ſtronger proof of the inferiority of the plough, with reſpect to profit, than the ſuperior punctuality of the dairy farmer in the payment of his rent. This obſervation, I believe, moſt ſtewards who *ſuperintend manors* devoted *partly* to corn and *partly to dairy farms, will verify; at leaſt I have never met with one who controverts it. But perhaps the* advocate for the plough will deſire me not to confound the abuſe of a thing with its intrinſic excellence; and ſay, that the generality of corn farmers are moſt egregious ſlovens; that lands devoted to the plough are not confined to ſuch a mediocrity of profits as 20s. per acre; that the produce of artificial graſſes (without which a well managed arable farm cannot exiſt), far exceeds that of natural graſs both in reſpect of quantity and nutrition: that the ſtraw yard is a moſt convenient receptacle for the cow when freed from the pail. Theſe, and many other reaſons, may be adduced to ſhew the propriety of walking in the middle path, and of judiciouſly blending *arable* with *paſture*, in the proportion perhaps of *three* of the latter to *one* of the former."

On theſe letters we ſhall only remark, that for the good of mankind we hope the notions contained in them will never be acted upon, even for the ſhorteſt period, on account of their tendency to raiſe the price of bread. They

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certainly never can be followed during a long period, as we are ſatisfied that they are founded on error, and have ariſen chiefly from not attending to the uſual ſituation of perſons holding ſmall corn and dairy farms. The dairy farmer uſually poſſeſſes a ſufficient capital, which enables him to carry on his buſineſs, which is of a very ſimple nature, to complete advantage; whereas, this is ſeldom the caſe with the holders of ſmall corn farms: but where the latter poſſeſs ſufficient capital to enable them to derive from the land every advantage which it is capable of beſtowing, there can be no doubt of the ſuperiority of the plough. In ſuch caſes, however, it is neceſſary that the arable farmer poſſeſs a large ſtock of cattle, to enable him to conſume advantageouſly the produce of the lands, and to preſerve them in an improving condition by large quantities of manure. In the Bath Papers, vol. v. p. 43. we have a method propoſed by Mr Wimpey of improving ſmall arable farms in ſuch a manner as to make them yield as much milk, butter, and cheeſe, as thoſe which are kept continually in paſture. He agrees with the maxim already mentioned, that ſmall arable farms do not afford to the occupier ſo good a maintenance as dairy farms of the ſame value; and that the poſſeſſor of a dairy farm will do well and ſave money, while the former, with much toil and trouble, is ſtarving himſelf and family. Notwithſtanding this, he maintains, that there is an eſſential difference between ground that is naturally arable, and ſuch as is by nature adapted for paſture. Land which is naturally arable, according to him, can by no means be converted into paſture of any duration. "Such as, from a wild ſtate of nature, overrun with furze, fern, buſhes and brambles, has been ren-

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dered fertile by means of the plough, muſt be kept in that improved ſtate by its frequent uſe; otherwiſe it would ſoon revert to that wild barren ſtate which was its original condition. A farm, therefore, which conſiſts wholly, or almoſt ſo, of land that is properly arable, muſt ever continue arable; for it is not practicable to render it in any degree fertile but by means of the plough, or to keep it long in that ſtate even when it is made ſo." He is of opinion, however, that by raiſing crops proper for feeding cattle, the poſſeſſor of an arable farm may raiſe as great a number of horned cattle as one who has a paſture farm; the only queſtion is, Whether he can be reimburſed of his expences by the produce? "To aſcertain this fact (ſays he), we muſt inquire what may be the average expences of keeping a milch cow on a dairy farm for any given time. It is ſaid, upon very good authority, that the expence is generally from 3l. to 3l. 10s. per annum. Two acres and a half of paſture fit for this uſe is ſufficient to keep a cow the whole year through, and ſuch land is valued at from 25s. to 30s. per acre. At 25s. the keeping of each cow would amount to 3l. 2s. 6d. per annum. A dairy farm, therefore, conſiſting of 48 acres, at 25s. per annum, would amount to 60l. rent; and the number of cows that might be kept on ſuch a farm would be about 20. In the next place, with regard to the expence of keeping a cow upon food raiſed in arable land as a ſuccedaneum for graſs, we are aſſured by unqueſtionable authority, that a buſhel of potatoes, given half at night and half in the morning, with a ſmall allowance of hay, is ſufficient to keep three cows a day; by which allowance their milk will be as rich and as good as in the ſum-

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mer months when the cows are in paſture. An acre of land, properly cultivated with potatoes, will yield 337 buſhels; and the total expence of cultivation, rent and tithe included, will not exceed 6l. 13s. If three cows eat ſeven buſhels per week, then they would eat 364 buſhels in a year; and 20 cows would conſume 2433 buſhels:" So that, according to this calculation, ſeven acres and a quarter would nearly maintain as many cows as on the paſture farm could be maintained by 48 acres. If then the cultivation of one acre of ground coſts 6l. 13s. the cultivation of ſeven acres and a quarter will coſt about 48l. We have ſeen, however, that the rent of a dairy farm capable of maintaining 20 milch cows, is not leſs than 60l. ſo that the calculation is thus entirely in favour of the arable farm; ſeven or eight acres of the arable farm being ſuperior by 12l. in value, when cultivated with potatoes, to 48 acres of meadow or paſture ground. "It muſt indeed be obſerved (adds our author), that in this ſtatement no allowance is made for the ſmall quantity of hay given to the cows with the potatoes. It muſt be noted alſo, that the account of cultivation is charged with 40s. an acre for manure, and ſome expence for ploughing, which of right is chargeable to the crop of wheat that is to follow. Now, if we deduct 40s. an acre from the expence of cultivating the potatoes, it reduces the ſum to 4l. 13s.; and the whole expence upon ſeven acres and a quarter is thus leſs than 34l. and conſequently the keeping of 20 cows is little more than half to the occupier of the arable farm what it is to the occupier of the grazing farm. If this concluſion be fairly drawn, and the calculation free from errors, it is matter of the greateſt import-

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ance, eſpecially to the little arable farmer. It plainly raiſes him from a ſtate of acknowledged inferiority to one greatly ſuperior."

Objection anſwered from an experiment of Mr Vagg.

Our author next proceeds to obviate an objection, "that the whole of his reaſoning muſt be indeciſive, as relating only to potatoes." In oppoſition to this, he adduces an experiment made on a pretty large ſcale by Mr Vagg; from which it appears, that cabbages, when raiſed upon arable ground, are nearly as much ſuperior to a natural crop as potatoes are. Twelve acres were employed in this experiment, and thoſe of an indifferent quality. The rent was 30s. per acre, and the whole expence of culture and carting off the crop amounted only to 1l. 14s. ſo that all the coſt of the twelve acres was 38l. 9s. From the produce were fed 45 oxen and upwards of 60 ſheep; and he was aſſured that they improved as faſt upon it as they do in the beſt paſture months, May, June, and July. "Now (ſays Mr Wimpey), if inſtead of 60 ſheep we reckon 15 oxen, or that four ſheep are equal to about one ox, in which we cannot err much; then 60 oxen were kept well for three months, or, which is the ſame thing, 15 for a whole year, for 38l. 9s.; and conſequently 20 oxen would coſt 51l. 5s. 4d. which is not quite 3l. more than the keeping of 20 cows would coſt in potatoes. Turnips, turnip-rooted cabbage, carrots, parſnips, and ſome other articles, by many experiments often repeated, have been found quite adequate to the ſame valuable purpoſes; at leaſt ſo far as to be more lucrative than meadow or paſture. Clover and rye-graſs are omitted, as having been long in general practice; but are uſually very ſhort of the advantages which may be derived from the culti-

Number of cattle fed from 12 acres of cabbages.

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vation of the other articles recommended." Sainfoin is greatly recommended; but our author acknowledges that it makes but a miſerable appearance the firſt year, though afterwards he is of opinion that one acre of ſainfoin is equal to two of middling paſture ground; for which reaſon he accuſes the farmer of intolerable indolence who does not cultivate ſo uſeful a plant. On this ſubject, however, we muſt remember, that the culture of ſainfoin is clogged with the loſs of one if not two crops; which may ſometimes be inconvenient, though afterwards it remains in perfection for a great number of years. The moſt advantageous method of raiſing it he ſuppoſes to be after potatoes. In this way it will thrive even upon very poor ground; as the culture and manure neceſſary for the potatoes both pulverize the ſoil and enrich it to a ſufficient degree.

The opinions here ſtated are ſupported and maintained by the beſt informed authors, in ſuch a manner as to leave no doubt of their truth. The Reverend Edmund Cartwright recommends, upon arable farms, the following courſes of crops with a view to this ſubject *. "On ſtrong lands, ſays this writer, the following courſes I have known ſucceſsfully practiſed: 1ſt, beans; 2d, wheat; 3d, cabbages; 4th, barley; 5th, clover: this courſe preſents three ameliorating crops to two exhauſting ones. 1ſt, Potatoes; 2d, wheat; 3d, turnips (carried off); 4th, barley, and ſometimes oats: this was a very common courſe about twenty years ago in a bleak part of Derbyſhire, where I formerly reſided. 1ſt, Wheat; 2d, tares, and

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* *Communications to the Board of Agriculture*, vol. iii.

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and afterwards turnips; 3d, barley; 4th, clover, or 5th, wheat; 6th, tares; 7th, oats; 8th, turnips. Theſe were the general courſes, with few deviations, obſerved by a Leiceſterſhire farmer.

"It admits not of a queſtion," adds he, "that an acre of clover, tares, rape, turnips, or cabbages, will furniſh at leaſt twice the food that the ſame acre would have done had it remained in paſture: by any one of theſe courſes, therefore, it follows, that the land would maintain at leaſt as much ſtock as when in graſs, beſides producing every other year a valuable crop of corn. No calculation is made upon the value of the ſtraw, which, whether conſumed as litter or as food, will add conſiderably to the ſtock of manure.

"That the condition of the land would be improved there can ſcarcely remain a doubt upon the mind of any man who will conſider the ſubject attentively. The plough, by pulverizing the ſoil and breaking its tenacity, not only gives admiſſion to the fertilizing influence of the atmoſphere, but, by intimately mixing the manure, prevents that tenacity from taking place in future, ſo long at leaſt as the manure remains totally unexhauſted. But as the ſoil will have a freſh and ample ſupply, every other year, the ſtock of manure, with its concomitant fertility, will rather accumulate than be diminiſhed; in conſequence of which, whenever it is again converted into paſture, it will be in ſuperior condition to what it was when firſt broken up."

Feeding of cattle not brought to perfection.

We ſhall afterwards have an opportunity of attending to this ſubject when we come to conſider the ſubject of feeding cattle. In the mean time, it may be remarked, that this branch of the art of the huſbandman, has by no means hitherto been carried to its higheſt perfection in this country; and that in proportion as it is improved, and cattle are more carefully ſed, the value of the plough will appear more conſpicuous.

Profit from different Vegetables.

SECT. III.

OF THE COMPARATIVE PROFIT TO BE DERIVED FROM THE CULTIVATION OF DIFFERENT VEGETABLES.

Circumſtance that render vegetables ſuitable or not.

LIKE every other artiſt or tradeſman, a huſbandman will always be under the neceſſity of regarding himſelf as the ſervant of the community, and muſt endeavour to rear the vegetables that are in greateſt demand, and that will enable him to derive the greateſt profit from the portion of territory which he occupies. The product of ſome ſoils and ſituations is ſo fixed by nature, that it is in vain for human art or induſtry to alter her deſtination. In our own and in many other countries, there are extenſive tracts of lofty and rugged mountains, from which the art of agriculture ſeems to be for ever baniſhed. Such ſituations belong excluſively to the ſhepherd and his flock, to the utter excluſion of the plough. Even on ſome arable lands it may be found fruitleſs to attempt to rear many of the more valuable vegetable productions. In many bleak and unſheltered fields of the higher country of Scotland, in which turnips and oats are cultivated with tolerable ſucceſs, it would be in vain to expect regular crops of wheat; and though potatoes are found to proſper in a ſandy, or even a moſſy ſoil, it would be in vain to expect

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them to produce an equally valuable crop upon a ſtiff clay, in which the roots cannot ſwell or expand to a proper ſize. In forming a plan of agriculture, therefore, the huſbandman muſt not overlook the peculiar nature of the ſoil that has fallen to his lot, or its phyſical relation to the nature of certain vegetables, as he can only hope for ſucceſs by adapting the one of theſe to the other.

The huſbandman muſt alſo have a ſpecial regard to the ſtate of the market to which his commodities are to be brought. It is in vain for him to cultivate large quantities of roots, ſuch as potatoes or carrots, at a diſtance from great towns, which alone can afford a market for them, unleſs he intend to conſume them upon his own farm by feeding cattle. In a part of the country, however, in which great breweries are eſtabliſhed, if his ſoil is fit for the purpoſe, he may ſafely venture to rear large quantities of barley; as he cannot in ſuch a ſituation be at any time deſtitute of a market. Hence we can perceive, that it is the ſtate of the market which muſt at all times regulate the enterpriſes of the agriculturiſt, and the kind of crops which he is to bring forward. Thus alſo we ſee the mode in which agriculture may be moſt ſucceſsfully encouraged by a nation. Let an abundant market be provided for the produce of the ſoil, and that produce will infallibly be augmented. In this way, it is evident that the conſumption of grain, by means of diſtilleries or breweries, is highly favourable to the production of it in great quantities. They are even favourable to the exiſtence of plenty, or of abundance of bread for the uſe of the people. In good ſeaſons, by affording a ready market, they give acti-

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vity to the huſbandman, and in bad ſeaſons their operations can be arreſted by law, and the ſuperfluous quantity of grain which was meant to be conſumed by them, can be converted into human food. Thus they operate in ſome meaſure like a great public granary, in which proviſions ſhould be kept againſt an accidental ſcarcity.

It may ſometimes happen, that by the character of the age in which he lives, and the ſtate of the market which it produces, a huſbandman may find himſelf moſt profitably employed, when rearing a kind of food which is by no means the moſt advantageous to the population of his country. This takes place, when he is employed in preparing butchers meat inſtead of bread; that is, when he finds it more profitable to rear upon his lands vegetables which can only be conſumed by cattle, and thus contribute only in an indirect manner to the ſuſtenance of the human ſpecies, than to cultivate thoſe vegetable productions which are ſuited to the human ſtomach, and which therefore directly and immediately afford ſubſiſtence to man. According to Archdeacon Hiſlop's comparative ſtatement, lately publiſhed, the weight of food from an acre of arable land, on the average of three years, a fallow year being included, is nine and a half times greater than from an acre of feeding ſtock.

Paſturage and agriculture compared.

The Reverend Dr Walker of Collington, profeſſor of natural hiſtory in the univerſity of Edinburgh, in a memorial addreſſed to the Board of Agriculture, ſtates the ſubject thus *: He obſerves, that a Scots acre of good

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* *Communic.* vol. iii.

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land, of 40 ſhillings rent, which is capable of producing 1280 pounds of oat-meal in a ſeaſon, will only produce 120 pounds weight of mutton. He then adds, "The difference which ariſes to the public from theſe two different methods of occupying land, is indeed moſt ſurpriſing. A labourer, a manufacturer, or a mechanic, often conſumes at the rate of a pound of meat each day. The 120 pounds of meat, therefore, afforded by the above acre, cannot ſupport ſuch a conſumer above one-third of the year. He requires no leſs than three ſuch acres to ſupply his wants for the ſingle article of meat. On the other hand, the ſingle acre affording 1280 pounds of oat-meal is capable of ſupporting three laborious men in health and vigour, and with leſs additional ſuſtenance than the former conſumer requires.

"The labourer, therefore, who lives chiefly on meat, demands for his ſupport about nine times the quantity of land that is neceſſary for the ſuſtenance of a labourer who lives chiefly on grain."

Let it even be ſuppoſed, however, that one pound of mutton contains in itſelf as much ſubſtantial nouriſhment for the human conſtitution, as two pounds weight of oat meal; ſtill it will follow, that land cultivated for the production of oats, will ſupport a population five times greater in number, than can be ſupported by the ſame land when uſed for the paſture of ſheep; and, where one million of people are found to exiſt upon a territory occupied in the one way, between five and ſix millions of people might exiſt upon the ſame land, if it were cultivated for raiſing grain, and if the inhabitants would conſent to uſe it as their food. Were any contrivance adopted,

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of the nature of thoſe already mentioned, for converting the ſucculent roots of potatoes, carrots, &c. into dry meal or flour; the ſame proportional difference of population would continue to exiſt, between nations in which that kind of flour ſhould be conſumed as human food, and in which it ſhould be uſed for feeding cattle: For a man always commits an enormous waſte of food, who, inſtead of eating grain himſelf, gives it to an inferior animal, in the expectation of afterwards receiving an equivalent, by devouring the fleſh of that animal.

Population greateſt where men live on vegetable food.

Accordingly, it ſeems impoſſible for any nation to reach a very extenſive degree of population, unleſs the people at large conſent to ſubſiſt, in a very conſiderable degree, upon vegetable food. In China, where the practice of polygamy renders the families of rich men very numerous, and where the equal diſtribution of the property among the children of the ſame family prevents the accumulation of great wealth by individuals, almoſt all perſons have found it convenient or neceſſary to relinquiſh the ordinary uſe of butchers meat, and to have recourſe to vegetable food. It is only in conſequence of this circumſtance, that the enormous population of that empire is ſupported. The quantity of butchers meat conſumed in a country will, therefore, always in ſpite of every agricultural improvement, ſet bounds to its population. A nation of hunters and ſhepherds, who live upon wild animals, or upon flocks and herds, muſt always be few in number. By agriculture, the numbers of theſe animals may indeed be increaſed; but the men who can find ſubſiſtence by conſuming them, will always be five or ſix times fewer in number, than might live upon the

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ſame territory, were the cattle expelled, and the lands occupied in rearing food to be immediately uſed by man.

It is to be obſerved, however, that, independent of the public taſte and manners, this laſt idea of the expulſion of cattle, or the total relinquiſhment of animal food, is in our ſoil and climate, at leaſt in the preſent ſtate of the ſcience of agriculture, merely a ſpeculative notion, incapable of being reduced into practice, conſiſtently with the rules of good huſbandry. Our ſoil requires to be conſtantly renewed by the addition of manure, which can only be procured of the beſt quality and in abundance, at a diſtance from great cities, by means of cattle. We have already taken notice of the great ſuperiority of Britiſh over French huſbandry. That ſuperiority ariſes entirely from the cattle kept upon our farms, which enable their owners, by manure and by ameliorating green crops, to raiſe larger quantities of corn than can be done in any other way, while, at the ſame time, a great ſupply of butchers meat is over and above provided. When cattle, therefore, are reared only in moderate numbers, for the purpoſe of conſuming the green crops upon a farm, to afford the means of improving the fertility of the ſoil, they ought not to be regarded as diminiſhing the quantity of human food; but, on the contrary, as greatly increaſing it, by enabling the agriculturiſt to bring to market larger quantities of grain than could otherwiſe be done; while, at the ſame time, a ſupply of the moſt nouriſhing of all food is over and above provided for the uſe of man. Thus Providence ſeems to have contrived to render it the intereſt of the human race to preſerve, and to give ſubſiſtence to great numbers of the inferior animals, by enabling theſe animals to pay liberally for the protection which they receive.

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Circumſtances that lead huſbandmen to prefer paſturage to the rearing of grain.

With theſe general conſiderations, however, the practical agriculturiſt, or huſbandman, may have nothing to do. To ſucceed in his profeſſion, he muſt accommodate himſelf to the public taſte, or to the ſtate of the market around him; and muſt conſider what commodity, whether grain or butchers meat, will there bring the beſt reward for his labour. He may even find the ſtate of the market affected by other circumſtances, than the mere taſte of the public for butchers meat, in preference to vegetable food; although that muſt always be of great importance among a luxurious people. Conquering nations, who extend their political dominion over diſtant regions, never fail to draw to their native country a very great portion of the wealth of the vanquiſhed ſtates. The victorious nation never fails, in ſuch caſes, to contain a great number of wealthy individuals, whoſe revenue is not derived from the cultivation of their native ſoil, or from any branch of manufacture or of commercial induſtry carried on by them upon it; but which conſiſts of money drawn from the remote provinces of the empire, in conſequence of eſtates poſſeſſed, or fortunes acquired there, [illegible] the ſervice of government. The reſult of ſuch circumſtances naturally is, that theſe wealthy individuals not only live at home in a luxurious manner, and increaſe to an immenſe extent the conſumption of butchers meat by themſelves and their numerous retinue; but for the ſake of oſtentation, and as the only means of employing their wealth, they maintain great numbers of carriages and of riding horſes. To ſupport ſuch eſtabliſhments, they themſelves

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ſelves not only convert large tracts of territory from arable into paſture lands; but even the whole huſbandmen of the country are induced to do the ſame, to derive a profit from ſupplying them with butchers meat, and with food for their pleaſure horſes. In the mean time, the grain that may be wanted for the conſumption of the people, whether rich or poor, being a commodity which is eaſily preſerved and tranſported, muſt be brought from foreign nations, by a portion of the ſuperfluous wealth of the ſtate; and thus a rich and proſperous people may come to depend upon foreigners for a morſel of bread; and, when theſe foreign nations happen to experience an unfortunate ſeaſon, this wealthy people may ſuffer all the horrors of famine upon a fertile ſoil, and in the midſt of overflowing treaſures.

Such was the ſtate of Italy under the ancient Romans. Every part of it was adorned with the parks and villas and gardens of the nobles, who derived their revenues from the remote parts of the empire. This ſeat of dominion exhibited a picture of boundleſs ſplendour and magnificence. But the ſoil was entirely occupied in the ſervice of oſtentation or of luxury; and Italy, one of the moſt fertile corn countries in Europe, depended for grain upon Egypt, and the weſtern provinces of Africa that border upon the Mediterranean. Such alſo, though perhaps in an inferior degree, ſeems to be the preſent ſtate of Great Britain. It has acquired vaſt and fertile and populous provinces, within the torrid zone in the eaſt, from which individuals are annually tranſporting home immenſe treaſures obtained in the public ſervice. In the weſt, alſo, within the ſame torrid zone, by a great expence of treaſure and of human

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man lives, the cultivation of certain valuable commodities has been eſtabliſhed; and from eſtates ſituated there, individuals reſiding at home now derive great revenues. The principles which regulate human affairs are unalterable; and in every age the ſame cauſes are attended with the ſame conſequences. What occurred in ancient Italy, took place among us as ſoon as the poſſeſſion of diſtant territories had leiſure to diſplay its natural effects. Britain formerly not only produced abundance of grain, for the ſupport of its own inhabitants, but it poſſeſſed a conſiderable ſurplus for exportation. After the acquiſition of foreign poſſeſſions, this ſurplus produce gradually ceaſed to exiſt; and it appears from documents, which the legiſlature has acknowledged to afford authentic and complete evidence of the truth of the fact, that, for twenty years paſt, notwithſtanding all our agricultural improvements, and the waſte lands that have been brought under the plough, the produce of grain is annually becoming more and more unequal to the conſumption; and this decreaſe appears in ſome meaſure to keep pace with the increaſing value of our diſtant poſſeſſions. In the mean time, we are annually coming under the neceſſity of purchaſing larger and larger ſupplies of grain, from the foreign ſtates of Europe or of North America; and thus theſe nations, without undergoing the imputation of uſurpation, and without encountering the hazard of an unfriendly climate, have been enabled through the medium of our luxury to obtain a ſhare of the riches of Hindoſtan, and of the profits of our Weſt India cultivation. In the mean time their agriculture is encouraged, while we are made to depend upon them for the neceſſaries of life. After all, it appears unreaſonable, and would perhaps be improper,

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to regret a ſtate of affairs, which is the reſult of national aggrandizement, and of the ſuperiority and ſucceſsful enterpriſes of our countrymen. Still, however, it is obviouſly to be wiſhed, that, ſo far as agriculture is concerned, we could be reſtored to the ſtate of independence which our anceſtors enjoyed, when they were able, from their own ſoil, to ſupply themſelves with the neceſſaries of life: ſuch a ſtate is ſometimes neceſſary to the independent exiſtence of a community, and is at all times conducive to its welfare. It can only however be produced by means of agriculture. Therefore,

> Ye generous Britons, venerate the *plough*,
> And o'er your hills and long withdrawing vales,
> Let autumn ſpread her treaſures to the ſun;
> So with ſuperior boon may your rich ſoil,
> Exuberant, nature's better bleſſings pour
> O'er every land, the naked nations clothe,
> And be th' exhauſtleſs granary of a world!
>
> THOMSON.

SECT. IV.

GENERAL PRINCIPLES OF CULTIVATION.

It is not our intention here to enter into a minute diſquiſition, concerning the nature of vegetables, & the different ſubſtances with which they may be connected, in their growth or in their decay. Such inveſtigations, in a proper arrangement of the ſciences, ought to be left

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to chemiſtry; but even that ſcience, ſo far as vegetable ſubſtances are concerned, is ſtill in ſuch a ſtate of imperfection, that a detail of the experiments and opinions of philoſophical chemiſts, concerning vegetables, would as yet afford but a very trifling portion of uſeful information to the huſbandman. We ſhall therefore content ourſelves with here ſtating ſuch general remarks, as appear neceſſarily connected with the important art of which we are now treating.

Nature of the growth of vegetables.

A vegetable is not to be regarded merely as a piece of matter, or as a mixture of certain material ſubſtances. It is an organized being, poſſeſſed of life, which is derived from another ſimilar organized being that exiſted previous to itſelf; and this former organized and living being derived its conſtitution from a parent ſtem, which grew out of a ſtill older plant, up to an antiquity of which we have no knowledge. A vegetable, in this manner, not only has a birth, but it alſo has a growth, which is ſupported by food that it takes in and conveys by peculiar organs to the particular parts for which it is deſtined. When it has arrived at maturity, or reached the perfection of its form and conſtitution, a vegetable, like an animal, begins to decay, and finally dies, and, by a proceſs of putrefaction, is converted into a kind of earth.

To the life of vegetables, in the ſame manner as to the life of animals, the preſence of atmoſpheric air is neceſſary. They alſo require a certain moderate degree of heat; without which their growth cannot proceed, although a great degree of it is utterly fatal even to their texture. That they require moiſture, is equally obvious; as appears from the ordinary effect of rain, or of the continued want of it, upon fields and plants.

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They require likewiſe to be inſerted in the earth, or in ſome way connected with a collection of its particles; for although ſome plants, particularly the bulbous-rooted kinds, vegetate in pure water and air alone, it appears that they acquire little addition of ſolid ſubſtance, and that neither they, nor any of the other larger plants, reach perfection, or produce ſeed, unleſs planted in the earth, or ſupplied with a portion of it.

As all ſoils are by no means equally adapted for ſupporting vegetables, or bringing them to maturity, it is neceſſary for the huſbandman to attend to their nature, and the modes in which they may be altered or ameliorated for his uſe. Independent of theſe hard concretions, which obtain the name of ſtones or rocks, it is to be obſerved, that the looſer and more diviſible earth which covers moſt part of the ſurface of the globe, and receives the appellation of *the ſoil*, may, upon the whole, and with ſufficient accuracy for practical purpoſes, be divided into four kinds, which are in general mixed with each other, but which receive their name, in ordinary language, from the kind that predominates, or is moſt abundant. Theſe are ſand, clay, chalk, and garden mould. Of theſe, ſand and clay are in ſome meaſure the oppoſites of each other, while chalk forms a kind of medium between them. Sand allows water to filter rapidly through it, and ſpeedily becomes dry, while clay is extremely tenacious of moiſture; but a mixture of chalk renders ſand conſiderably more tenacious of water, while it renders clay more looſe and eaſily penetrated. None of theſe ſoils, when pure, are valuable for the purpoſes of agriculture.—Sand does not ſufficiently retain water for the uſe of vegetables; nor does clay ſufſer their roots to expand with freedom in queſt of nouriſhment. Chalk, or, as it is uſually called, a calcareous ſoil, is not of itſelf adapted for raiſing uſeful plants; for, although it may not have the mechanical defects of ſand and clay, yet, it is found by experience to be of little value to them, either in conſequence of its tendency to deſtroy their texture by its corroſive quality, that is, by having too much chemical affinity with the materials of which they conſiſt, or from its not containing within itſelf the proper materials neceſſary to them as food.

The fourth kind of ſoil we have denominated garden mould; becauſe it is in its higheſt perfection when it approaches neareſt to the rich black earth which receives that appellation. This is the moſt proper of all kinds of ſoil for rearing the whole of thoſe vegetables which are accounted valuable in our climate. In proper circumſtances, that is, with a moderate degree of heat and of moiſture, it never fails to ſend forth and to bring to perfection an abundant crop. In proportion to the degree in which any ſoil conſiſts of this black mould, its value increaſes. If, therefore, a huſbandman could cover the portion of territory allotted to him with a tolerable depth of this kind of ſoil, nothing more would be neceſſary to the ſucceſs of his enterpriſes, as he could rear whatever vegetables he thought fit, in perfection, and in great profuſion. It is to be obſerved, however, that this kind of mould or ſoil cannot be relied upon as permanent. If crops of grain ſhould be taken from it year after year, it would ſoon loſe its fertile qualities, and become unfit for the purpoſes of a proſperous agriculture. Here then is the remarkable difference between this kind of ſoil and the three others rinciples Cultivation.

that were formerly mentioned, ſand, clay, and chalk.—Whatever properties theſe poſſeſs are unperiſhing, and can only be altered or modified by the operation of a fierce heat. Unfortunately, however, in their pure ſtate, as already mentioned, they are of little value to the huſbandman; and it is only in proportion to the degree in which they are mixed with the dark coloured or garden mould, that they become adapted to his purpoſes: but as the qualities of this mould are of a tranſitory nature, it is of the utmoſt importance, and ought indeed to form the great baſis of every theory of agriculture, to explain how they may be preſerved in exiſtence, or reſtored when loſt.

roceſs by which na- ure fertilizes the earth.

To underſtand this ſubject correctly, it is neceſſary to conſider the nature and origin of this fertile mould. It is evidently not one of thoſe original ſubſtances which form a part of the great maſs of the ſolid globe of the earth, but appears to be the reſult of the operations and of the deſtruction of living and organized beings that have exiſted upon it. "Were a naked rock, (ſays Mr Headrick, in an eſſay * which we ſhall afterwards have occaſion to mention), ſuddenly thrown up from the ſea or from the bowels of the earth, the firſt plants which nature would place upon it, would be the various ſpecies of *lichens*, and ſuch as can ſubſiſt wholly upon what they imbibe from the air, without needing a ſoil in which to puſh their roots. Theſe plants ſerve the double purpoſe of clothing the rock, and thus preventing the fine particles that are diſſolved by air and moiſture from being waſhed away, and, from their

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* *Communications of the Board of Agriculture,* vol. ii.

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growth and diſſolution, of accumulating vegetable ſoil for the ſuſtenance of more ſucculent plants. The rock is thus gradually made to acquire ſuch a depth of ſoil, that it becomes able to ſuſtain not only graſſes and ſhrubs, but may become a receptacle for the oak itſelf." The progreſs here ſtated is correct; but ſome circumſtances muſt be added to it, to render it practically uſeful to the huſbandman. It is to be obſerved, then, that animal ſubſtances, after they have ceaſed to form a part of a living body, have a tendency to proceed rapidly into a ſtate of putrefactive fermentation, by which the greateſt part of their maſs is rendered volatile. When animal ſubſtances are mingled with vegetables, they ſpeedily communicate their own fermentation or putrefaction to the vegetables, which by means of it are decompoſed, fall to pieces, and are transformed into that kind of black earth, which we have called garden mould, and which forms the moſt fertile of all ſoils for the production of vegetables. It is by this proceſs then, that is, by the fermentation of vegetable by means of animal ſubſtances, that the ſurface of this globe has been fertilized, or a black and rich mould produced upon it, as we daily ſee taking place in a variety of ſituations. No ſooner do the ſmall lichens or moſſes cover the face of the naked rock, or gravel, or clay, than a variety of ſpecies of ſmall animals appear, and feed upon them. As the plants and animals die in ſucceſſion, their ſubſtances mingle and give riſe to the putrefaction already mentioned, which is productive of a ſmall portion of ſoil. A new race of plants of greater ſtrength and bulk riſes upon the ruins of the firſt, and ſupports larger animals, all deſtined in their turn to periſh and to increaſe the inciples Cultivation.

quantity of fertile ſoil. Mòre valuable graſſes ſoon ſupplant the original ſmall and coarſe vegetables, and the ſpot aſſumes the appearance of a rich verdure. New ſpecies of animals alſo begin to inhabit it: ſnails and worms abound; and by their remains contribute to the diſſolution of the roots of plants which everywhere penetrate the new ſoil, and to the decompoſition of the ſtems which periodically fall down. When the ſoil has acquired ſufficient depth, it is ſheltered by ſhrubs; and, laſtly, by foreſt trees, under the ſhade of which the larger animals exiſt. The trees ſhed their leaves every ſeaſon, and every ſeaſon conſequently gives an additional layer or *ſtratum* of fertile mould to the ſoil: and thus, while the foreſt endures, the fertility of the territory on which it ſtands continues to be augmented by its ſpoils, and by the bodies of the animals which repair to it for ſhelter.

This proceſs, by which nature gives fertility to the earth, or creates the rich mould on which vegetables flouriſh, ought to be imitated by the huſbandman; and, in fact, it has been imitated, in conſequence of a knowledge that is derived from experience and from practice, rather than from the general ſpeculations of ſcience. The imitation of nature upon this point conſtitutes the art of producing manures, which will be afterwards conſidered. The principle upon which it proceeds, reſts upon this foundation, which is known to be true in fact, that the fermentation of animal and vegetable ſubſtances produces that kind of dark rich mould which forms the moſt fertile ſoil.

In what way, or by what peculiar operation, this kind of mould or ſoil becomes ſo highly conducive and ſubſervient to the growth of plants, is a point of more difficult

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difficult reſearch, and is fortunately of leſs importance to be known to the practical agriculturiſt. It may be obſerved, however, that this mould poſſeſſes, in an eminent degree, all the requiſites neceſſary to the ſucceſs of vegetation. It retains moiſture, which is ſo neceſſary to that proceſs, without, at the ſame time, keeping hold of it with that retentiveneſs which, in clay, has the effect of injuring the roots of the plants. As this mould conſiſts of the remains both of animal and vegetable life, it neceſſarily contains an immenſe variety of ingredients which have different degrees of chemical affinity to each other. By the operation of theſe affinities in bringing the different ſubſtances into new combinations, a great quantity of heat muſt be continually produced or evolved, as occurs in ſo many chemical proceſſes. By this heat the roots of the plants will be nouriſhed, eſpecially when aſſiſted by the heat which they themſelves throw out or produce when germinating. Thus, by the kind of ſoil now mentioned, or by the aid of manure, the defects of a cold and ungenial climate may, in ſome meaſure, be rectified, and the ſeeds and roots of vegetables may be ſupplied with due and ſeaſonable warmth. It is alſo probable, that what is called the exhauſted ſtate of a ſoil, in conſequence of much ploughing, and many crops having been taken from it, may partly ariſe from this circumſtance, that all the chemical affinities having at laſt operated, every particle of the ſoil remains at reſt, and no more heat is produced by the activity of its parts.

Conjecture about exhauſted ſoils.

That plants growing in fertile mould like that now mentioned, derive nouriſhment or food from it, cannot be doubted, ſince we ſee, that when taken out of it, or placed in another but leſs favourable ſoil, they ſpeedi-

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ly go into decay. What the particular ſubſtances are, however, which they take from it, has not been diſcovered. But it appears from the minuteneſs of the extreme fibres of the roots of plants, that the food which they abſorb muſt be ſoluble in water, or in a liquid ſtate when taken in by them. Accordingly, their food is actually found to aſcend through their organs in a liquid form. Of this liquor or ſap there are two kinds, the aſcending and the deſcending. The aſcending ſap is that which riſes in the ſpring; and by cutting a ſhort way through the bark into the wood of many trees, large quantities of it may be drawn off, without injury to their health or growth. This ſap aſcends to the leaves, and there undergoes ſome change by the action of the air; for the leaves of vegetables appear to perform to them an office ſimilar to that which is accompliſhed in animals by the organ called the *lungs*. From the leaves the ſap, thus changed, deſcends to every part of the plant, and contributes to its growth by becoming a part of its ſubſtance. It would ſeem, however, that the liquors which circulate in plants, not only undergo a change at the leaves, but alſo at their firſt entrance by the veſſels of the roots; for if ſeveral different kinds of trees are ingrafted upon the ſame common ſtock, each of them is able to derive the ſap peculiar to itſelf from the ſap of the common ſtock. Thus alſo the chemiſts have informed us, that vinegar, called by them the *acetous acid*, is found variouſly combined in the aſcending ſap of various trees; but it has never yet been diſcovered, that vinegar exiſts in any perceptible quantity in vegetable mould. That ſubſtance, therefore, muſt be formed by the root, by bringing together the ingredients of that acid which it finds and ſelects in the earth.

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When any plant, whether great or ſmall, is put into a cloſe veſſel, and ſtrongly heated, allowing only the ſmoke to eſcape, the reſidue in all caſes is of the ſame nature, and is called *charcoal*, or by the chemiſts *carbon*. Of this carbonaceous matter a conſiderable quantity is always found in rich garden mould, derived no doubt from the remains of vegetable ſubſtances of which that mould was originally formed. This carbonaceous matter, however, or charcoal, being inſoluble in water, cannot in its ordinary ſtate enter into the veſſels of growing vegetables; but, as it is rendered ſoluble by a variety of combinations, it is no doubt found out in ſuch a ſtate by the fibres of growing roots, and conveyed upwards in the juice. But as all vegetable mould, and the charcoal or carbonaceous matter which it contains, is the reſult of the ruins of vegetation, and as the lichens or vegetables of the coarſeſt and ſimpleſt kind, which originally grow upon the naked ſtone, have no other nouriſhment than water and atmoſpheric air, it is probable, that out of theſe materials they are capable of forming the charcoal, which conſtitutes the baſis of their form, and of the conſtitution of every other vegetable. It is true, that the chemiſts ſtill regard carbon or charcoal as a ſimple and uncompounded ſubſtance; and they have not found it in water, nor in atmoſpheric air, unleſs in the moſt minute degree, reſulting probably from the combuſtion of fires and the breathing of animals in inhabited countries. But although chemiſts have not hitherto been able to find charcoal in the three ſimple ſubſtances, oxygen, hydrogen, and azote, of which atmoſpheric air and water are compoſed, it ſeems evident, that the mighty Chemiſt who contrived this world and the con-

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ſtitution of vegetables, finds no difficulty in forming it of thoſe materials by means of their organization. Hence we rather think, that water and air muſt conſtitute the original food of the ſimpleſt and coarſeſt kind of plants; but if this idea be true, it is to be regarded as a fact that is more curious in ſpeculation than uſeful in practice: for it is certain, that the more valuable and larger vegetables, which it is the buſineſs of the huſbandman to cultivate, cannot be reared to perfection without the aid of vegetable mould. Though they may poſſeſs, therefore, the power of deriving a portion of their ſolid ſubſtance, or of the carbonaceous matter which they contain, from common air and water, they cannot obtain the whole by this means, and require the aid of the remains of former vegetation. It is thus that one ſyſtem is ſeen to pervade every part of nature, as through all her works one claſs of animated beings only enjoys life in conſequence of the deſtruction of another. Thus the carnivorous animals conſume thoſe that live upon vegetables; and thus, in like manner, one ſpecies of vegetables only ſubſiſts upon the ruins, and is fed by the ſubſtance, of a former generation of plants.

getables the food each ier.

Beſides animal ſubſtances, there are ſome minerals that have a tendency to accompliſh the decompoſition of vegetables, and thereby to reduce them into a ſtate of mould, poſſeſſing in a great degree the qualities of the garden mould that is produced by the fermentation of the remains of animals and vegetables, the formation of which has now been deſcribed. Of the minerals that have this tendency, lime is the chief, and indeed the one commonly in uſe, either pure or when combined with clay under the form of marl. To the

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effect of lime, therefore, we ſhall call the attention of the reader.

Where the ground has been ſuffered to remain uncultivated for many ages, producing all that time ſucculent plants which are eaſily putrefied, and trees, the leaves of which likewiſe contribute to enrich the ground by their falling off and mixing with it, the ſoil will in a manner be totally made up of pure vegetable earth, and be the richeſt, when cultivated, that can be imagined. This was the caſe with the lands of America. They had remained uncultivated perhaps ſince the creation, and were endowed with an extraordinary degree of fertility; nevertheleſs we are aſſured, by perſons who have examined the lands in America, that ſuch grounds as have been long cultivated, are often ſo much exhauſted, as to be much worſe than the generality of cultivated grounds in this country. Here, then, we have an example of one ſpecies of poor ſoil; namely, one that has been formerly very rich, but has been deprived, by repeated cropping, of the greateſt part of the vegetable food it contained. The farmer who is in poſſeſſion of ſuch ground, would no doubt willingly reſtore it to its former ſtate; the preſent queſtion is, What muſt be done in order to obtain this end? We ſhall ſuppoſe the farmer tries lime. This ſubſtance, being of a ſeptic nature, or having a tendency to reduce vegetable ſubſtances into a ſtate of putrefaction, will act upon ſuch parts of the ſoil as are not putrefied, or but imperfectly ſo; in conſequence of which, the farmer will reap a better crop than formerly. The ſeptic nature of the lime is not entirely altered by any length of time. In ploughing the ground, the lime is more and more perfectly mix-

One ſpecies of poor ſoil deſtroyed by lime.

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ed with it, and gradually exerts its power on every putreſcible matter it touches. As long as any matter of this kind remains, the farmer will reap good crops; but when the putreſcible matter is all exhauſted, the ground then becomes perfectly barren; and the cauſtic qualities of the lime are moſt unjuſtly blamed for *burning* the ground, and reducing it to a *caput mortuum;* while it is plain the lime has only done its office, and made the ſoil yield all that it was capable of yielding.

A Species of poor ſoil meliorated by lime.

When ground has been long uncultivated, producing all the time plants, not ſucculent, but ſuch as are very difficultly diſſolved, and in a manner incapable of putrefaction; there the ſoil will be exceſſively barren, and yield very ſcanty crops, though cultivated with the greateſt care. Of this kind are thoſe lands covered with heath, which are found to be the moſt barren of any, and the moſt difficultly brought to yield good crops. In this caſe lime will be as ſerviceable as it was detrimental in the other; for by its ſeptic qualities, it will continually reduce more and more of the ſoil to a putrid ſtate; and thus there will be a conſtant ſucceſſion of better and better crops, by the repeated uſe of lime when the quantity firſt laid on has exerted all its force. By a continued uſe of this manure, the ground will be gradually brought nearer and nearer to the nature of garden mould; and, no doubt, by proper care, might be made as good as any: but it will be as great a miſtake to imagine, that, by the uſe of lime, this kind of ſoil may be rendered perpetually fertile, as to think that the other was naturally ſo; for though lime enriches this ſoil, it does ſo, not by adding vegetable food to it, but by preparing what it already contains; and when

all

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all is properly prepared, it muſt as certainly be exhauſted as in the other caſe.

Poor ſoils, how reſtored.

Here, then, we have examples of two kinds of *poor* ſoils; one of which is totally deſtroyed, the other greatly improved, by lime, and which therefore require very different manures; lime being more proper for the laſt than dung; while dung, being more proper to reſtore an exhauſted ſoil than lime, ought only to be uſed for the firſt.

By attending to the diſtinction between the reaſons for the poverty of the two ſoils juſt now mentioned, we will always be able to judge with certainty in what caſes lime is to be uſed, and when dung is more abſolutely neceſſary. The mere poverty of a ſoil is not a criterion whereby we can judge; we muſt conſider what hath made it poor. If it is naturally ſo, bearing heath and other coarſe plants, we may almoſt infallibly conclude, that it will become better by being manured with lime. If it is *artificially* poor, or exhauſted by continual cropping, we may conclude that lime will entirely deſtroy it. We apprehend, that it is this *natural* kind of poverty only which Dr Anderſon ſays, in his Eſſays on Agriculture, may be remedied by lime; for we can ſcarce think that experience would direct any perſon to put lime upon land already exhauſted. His words are,

Mr Anderſon's opinion concerning lime.

> "Calcareous matters act as powerfully upon land that is naturally poor, as upon land that is more richly impregnated with thoſe ſubſtances that tend to produce a luxuriant vegetation."

"Writers on agriculture have long been in the cuſtom of dividing manures into two claſſes, viz. *Enriching* manures, or thoſe that tended directly to render the ſoil more prolific, however ſterile it may be; among the foremoſt

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foremoſt of which was dung: *Exciting* manures, or thoſe that were ſuppoſed to have a tendency to render the ſoil more prolific, merely by acting upon thoſe enriching manures that had been formerly in the ſoil, and giving them a new ſtimulus, ſo as to enable them to operate anew upon that ſoil which they had formerly fertilized. In which claſs of ſtimulating manures, *lime* was always allowed to hold the foremoſt place.

"In conſequence of this theory, it would follow, that lime could only be of uſe as a manure when applied to rich ſoils—and when applied to poor ſoils, would produce hardly any, or even perhaps hurtful effects.

"I will frankly acknowledge, that I myſelf was ſo far impoſed upon by the beauty of this theory, as to be hurried along with the general current of mankind, in the firm perſuaſion of the truth of this obſervation, and for many years did not ſufficiently advert to thoſe facts that were daily occurring to contradict this theory.—I am now, however, firmly convinced, from repeated obſervations, that lime, and other calcareous manures, produce a much greater *proportional* improvement upon poor ſoils than ſuch as are richer;—and that lime alone, upon a poor ſoil, will, in many caſes, produce a much greater and more laſting degree of fertility than dung."

Thus far Dr Anderſon's experience is exactly conformable to the theory we have laid down, and what ought to happen according to our principles. He mentions, however, ſome facts which ſeem very ſtrongly to militate againſt it; and indeed he himſelf ſeems to proceed upon a theory altogether different.

Calcareous matter alone (ſays he) is not capable of rearing plants to perfection;—mould is neceſſary to be mixed with it in certain proportions, before it can form a proper ſoil. It remains, however, to be determined, what is the due proportion of theſe ingredients for forming a proper ſoil.

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Query concerning the nature of a proper ſoil.

"We know that neither chalk, nor marl, nor lime, can be made to nouriſh plants alone; and ſoils are ſometimes found that abound with the two firſt of theſe to a faulty degree. But the proportion of calcareous matter in theſe is ſo much larger than could ever be produced by art, where the ſoil was naturally deſtitute of theſe ſubſtances, that there ſeems to be no danger of erring on that ſide. Probably it would be much eaſier to correct the defects of thoſe ſoils in which calcareous matters ſuperabound, by driving earth upon them as a manure, than is generally imagined; as a very ſmall proportion of it ſometimes affords a very perfect ſoil. I ſhall illuſtrate my meaning by a few examples.

"Near Sandſide, in the county of Caithneſs, there is a pretty extenſive plain on the ſea coaſt, endowed with a moſt ſingular degree of fertility. In all ſeaſons it produces a moſt luxuriant herbage, although it never got any manure ſince the creation; and has been from time immemorial ſubjected to the following courſe of crops.

Examples of ſoil perpetually fertile.

"1. Bear, after once ploughing from graſs, uſually a good crop.

"2. Bear, after once ploughing, a better crop than the firſt.

"3. Bear, after once ploughing, a crop equal to the firſt.

" 4. 5. and 6. Natural graſs, as cloſe and rich as could be imagined, might be cut, if the poſſeſſor ſo inclined, and would yield an extraordinary crop of hay each year.

" After this the ſame courſe of cropping is renewed. The ſoil that admits of this ſingular mode of farming, appears to be a pure incoherent ſand, deſtitute of the ſmalleſt particle of vegetable mould; but, upon examination, it is found to conſiſt almoſt entirely of broken ſhells: the fine mould here bears ſuch a ſmall proportion to the calcareous matter, as to be ſcarce perceptible, and yet it forms the moſt fertile ſoil that ever I yet met with.

" I have ſeen many other links (downs) upon the ſea ſhore, which produced the moſt luxuriant herbage, and the cloſeſt and ſweeteſt pile of graſs, where they conſiſted of ſhelly ſand; which, without doubt, derive their extraordinary fertility from that cauſe.

" A very remarkable plain is found in the iſland of Jir-eye, one of the Hebrides. It has been long employed as a common: ſo that it has never been diſturbed by the plough, and affords annually the moſt luxuriant crop of herbage, conſiſting of white clover and other valuable paſture graſs, that can be met with anywhere. The ſoil conſiſts of a very pure ſhelly ſand.

" From theſe examples, I think it is evident, that a very ſmall proportion of vegetable mould is ſufficient to render calcareous matter a very rich ſoil. Perhaps, however, a larger proportion may be neceſſary when it is mixed with clay than with ſand; as poor chalky ſoils ſeem to be of the nature of that compoſition."

To theſe examples brought by Dr Anderſon, we may add ſome of the ſame kind mentioned by Lord Kaimes,

Kaimes. His lordſhip having endeavoured to eſtabliſh the theory of water being the only food of plants, though he himſelf frequently deviates from that theory, yet thinks it poſſible, upon ſuch a principle, to make a ſoil perpetually fertile.

"To recruit (ſays he), with vegetable food, a ſoil impoveriſhed by cropping, has hitherto been held the only object of agriculture. But here opens a grander object, worthy to employ our keeneſt induſtry, that of making a ſoil perpetually fertile. Such ſoils actually exiſt; and why ſhould it be thought, that imitation here is above the reach of art? Many are the inſtances of nature being imitated with ſucceſs. Let us not deſpair while any hope remains; for invention never was exerciſed upon a ſubject of greater utility. The attempt may ſuggeſt proper experiments: it may open new views: and if we fail in equalling nature, may we not, however, hope to approach it? A ſoil perpetually fertile muſt be endowed with a power to retain moiſture ſufficient for its plants, and at the ſame time muſt be of a nature that does not harden by moiſture. Calcareous earth promiſes to anſwer both ends; it prevents a ſoil from being hardened by water; and it may probably alſo invigorate its retentive quality. A field that got a ſufficient doſe of clay marl, carried above 30 ſucceſſive rich crops, without either dung or fallow. Doth not a ſoil ſo meliorated draw near to one perpetually fertile? Near the eaſt ſide of Fife, the coaſt for a mile inward is covered with ſea ſand, a foot deep or ſo; which is extremely fertile, by a mixture of ſea ſhells reduced to powder by attrition. The powdered ſhells, being the ſame with ſhell marl, make the ſand retentive of moiſture; and yet no quantity of moiſture will

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will unite the ſand into a ſolid body. A ſoil ſo mixed ſeems to be not far diſtant from one perpetually fertile. Theſe, it is true, are but faint eſſays; but what will not perſeverance accompliſh in a good cauſe?"

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eory.

Having thus, in a manner, poſitively determined with Dr Anderſon, that no doſe of calcareous matter can poſſibly be too great, we cannot help owning ourſelves ſurpriſed on finding his lordſhip expreſſing himſelf as follows: "An overdoſe of ſhell marl, laid perhaps an inch, and an inch and a half, or two inches thick, produces, for a time, large crops: but at laſt it renders the ſoil a *caput mortuum*, capable of bearing neither corn nor graſs; of which there are too many inſtances in Scotland. The ſame probably would follow from an overdoſe of clay marl, ſtone marl, or pounded limeſtone." To account for this, he is obliged to make a ſuppoſition directly contrary to his former one; namely, that calcareous matter renders the ſoil *incapable* of retaining water. This phenomenon, however, we think is ſolved upon the principles above laid down, in a ſatisfactory manner, and without the leaſt inconſiſtency.

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As to rendering ſoils perpetually fertile, we cannot help thinking the attempt altogether chimerical and vain. There is not one example in nature of a ſoil perpetually fertile, where it has no ſupply but from the air and the rain which falls upon it. The above recited examples can by no means be admitted as proofs of perpetual fertility. We know, that the graſs on the banks of a river is much more luxuriant than what grows at a diſtance: the reaſon is, that the water is attra[illegible]d by the earth, and communicates its fertilizing qualities to it; but was the river to be dried up, the

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graſs would ſoon become like the reſt. Why ſhould not the ocean have the ſame power of fertilizing plains near its ſhores, that rivers have of fertilizing ſmall ſpots near their banks? We ſee, however, that it hath not: for the ſea ſhores are generally ſandy and barren. The reaſon of this is, that the waters of the ocean contain a quantity of looſe acid; and this acid is poiſonous to plants: but, abſtracting this acid part, we heſitate not to affirm, that ſea water is more fertilizing than river water. It is impoſſible to know how far the waters of the ocean penetrate under ground through a ſandy ſoil. Where they meet with nothing to abſorb their acid, there the ground is quite barren; but in paſſing through an immenſe quantity of broken ſhells, the calcareous matter will undoubtedly abſorb all the ſuperfluous acid; and thus the ſoil will be continually benefited by its vicinity to the ocean. All the above fields, therefore, are evidently ſupplied with nouriſhment from the ocean: for if the ſalt water has ſufficient efficacy to render fields which are in its neighbourhood barren, why ſhould it not, like other water, render them fertile when the cauſe of barrenneſs is removed from it?

After all, the field in Caithneſs, mentioned by Dr Anderſon, ſeems to have been perpetually fertile only in graſs; for though the ſecond year it carried a better crop of bear than it did the firſt, yet the third year the crop was worſe than the ſecond, and only equal to the firſt. Had it been ploughed a fourth time, the crop would probably have been worſe than the firſt. Ground is not near ſo much exhauſted by graſs as corn, even though the crop be cut and carried off; and ſtill leſs if it only feeds cattle, and is manured by their dung; which appears to have been the caſe with this field.

Lord

Lord Kames, indeed, mentions fields in Scotland, that, paſt memory, have carried ſucceſſive crops of wheat, peaſe, barley, oats, without a fallow, and without manure; and particularizes one on the river Carron, of nine or ten acres, which had carried 103 crops of oats without intermiſſion and without manure: but as we are not acquainted with any ſuch fields, nor know any thing about their particular ſituation, we can form no judgment concerning them.

oils improved by mixture.

Defective ſoils are ſometimes improved by being mixed with each other. Thus clay, or a ſoil chiefly formed of that ingredient, is apt, as formerly noticed, to be hardened by the heat of the ſun, ſo that the vegetables can ſcarce penetrate it in ſuch a manner as to receive proper nouriſhment. Sand,on the contrary, if it is not ſituated ſo as to receive a great deal of moiſture, is very apt to be parched up in ſummer, and the crop deſtroyed; nor has it ſufficient adheſion to ſupport plants that have few roots and grow high. From theſe oppoſite qualities, it is evident that theſe two ſoils would be a proper manure for one another: the clay would give a ſufficient degree of firmneſs to the ſand, and the ſand would break the too great tenacity of the clay. According to Dr Home's experiments, however, ſand is the worſt manure for clay that can be uſed. He recommends marl moſt. To reduce clay ground as near as poſſible to the form of pure vegetable mould, it muſt firſt be pulverized. This is moſt effectually performed by ploughing and harrowing; but care muſt be taken not to plough it whilſt too wet, otherwiſe it will concrete into hard clods which can ſcarcely be broken. After it is pulverized, however, ſome means muſt be taken to keep it from concreting again into the ſame hard maſſes as before.

According

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According to Lord Kaimes, though clay, after pulverization, will concrete into as hard a maſs as before, if mixed with water; yet if mixed with dunghill juice, it will not concrete any more. Lime alſo breaks its tenacity, and is very uſeful as a manure for this kind of ſoil.

Fertility of the earth limited.

The concluſion, however, which we wiſh the practical farmer to draw from our theory is, That there is a certain limit to the fertility of the earth, both as to duration and to degree, at any particular time: that the nearer any ſoil approaches to the nature of pure garden mould, the nearer it is to the moſt perfect degree of fertility; but that there are no hopes of keeping it perpetually in ſuch a ſtate, or in any degree of approximation to it, but by conſtant and regular manuring with dung. Lime, chalk, marl, &c. may be proper to bring it near to this ſtate, but are abſolutely unfit to keep it continually ſo. They may indeed for ſeveral years produce large crops; but the more they increaſe the fertility for ſome years, the ſooner will they bring on an abſolute barrenneſs; while regular manuring with plenty of dung will always enſure the keeping up the ſoil in good condition, without any occaſion for fallow. What we have ſaid concerning the uſe of lime, &c. applies likewiſe to the practice of frequent ploughing, though in a leſs degree. This tends to meliorate ground that is naturally poor, by giving an opportunity to the vegetable parts to putrefy; but when that is done, it tends to exhauſt, though not ſo much as lime. A judicious farmer will conſtantly ſtrive to keep his lands always in good condition, rather than to make them ſuddenly much better; leſt a few years ſhould convince him that he was in reality doing almoſt irreparable rinciples f Cultivation.

parable miſchief, while he fancied himſelf making improvements. As for the ridiculous notions of ſtimulating the ground by ſaline manures, for the purpoſe of exciting it to perpetual fertility, we hope they will never enter the brain of any rational practitioner of agriculture.

In addition to what is here ſtated, however, concerning the diſtinction of ſoils in general, it may be neceſſary to take notice of the manner in which, with a practical view, they have uſually been diſcriminated by agricultural writers. This is the more neceſſary, on account of the frequent recurrence of various denominations of ſoil in treatiſes upon this important ſubject, the uſe of which, from the want of a ſcientific nomenclature, it will not be entirely in our power to avoid. Mr Young remarks, that in ſome parts of England where huſbandry is ſucceſsfully practiſed, any looſe clay is called marl, in others marl is called chalk, in others clay is called loam. To avoid increaſing this confuſion, we ſhall here follow the practical deſcription of ſoils given by the celebrated chemiſt Richard Kirwan, Eſq. previouſly obſerving, that by calcareous earth, is meant chalk and all ſtones that burn to lime, efferveſcing in their natural ſtate with all acids. Argil is pure clay, which forms alum with the vitriolic acid, but ſcarcely efferveſces with any of the acids. Siliceous earth is flint or pure ſand, ſuch as that whereof glaſs is made; it efferveſces with no acid. We may add that ferruginous earth, or iron, is the cauſe of the red or brown colour that appears in many ſoils.

“The ſoils moſt frequently met with, ſays Mr Kirwan, and which deſerve a diſtinct conſideration, are clay, chalk, ſand, and gravel, clayey loam, chalky loam, ſandy loam, gravelly loam, ferruginous loam,

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boggy ſoil, and heathy ſoil, or mountain as it is often called.

"Clay is of various colours; for we meet with white, gray, browniſh red, browniſh black, yellowiſh, or bluiſh clays; it feels ſmooth, and ſomewhat unctuous; if moiſt, it adheres to the fingers, and if ſufficiently ſo, it becomes tough and ductile; if dry, it adheres more or leſs to the tongue; if thrown into water it gradually diffuſes itſelf through it, and ſlowly ſeparates from it. It does not uſually effervesce with acids, unleſs a ſtrong heat be applied, or that it contains a few calcareous particles or magneſia. If heated, it hardens and burns to a brick.

"It conſiſts of argil and fine ſand, uſually of the ſiliceous kind, in various proportions, and more or leſs ferruginous. The argil forms generally from 20 to 75 per cwt. of the whole maſs, the ſand and calx of iron the remainder. Theſe are perfectly ſeparable by boiling in ſtrong vitriolic acid.

"Chalk, if not very impure, is of a white colour, moderate conſiſtence, and duſty ſurface; ſtains the fingers; adheres ſlightly to the tongue; does not harden when heated, but on the contrary, in a ſtrong heat, burns to lime, and loſes about $\frac{4}{15}$ of its weight. It effervesces with acids, and diſſolves almoſt entirely therein. I ſhall alſo add, that this ſolution is not diſturbed by cauſtic volatile alkali, as this circumſtance diſtinguiſhes it from magneſia. It promotes putrefaction.

"Sand.—By this is meant ſmall looſe grains of great hardneſs, not cohering with water nor ſoftened by it. It is generally of the ſiliceous kind, and therefore inſoluble in acids.

"Gravel differs from ſand chiefly in ſize; however, ſtones of a calcareous nature, when ſmall and rounded, are often comprehended under that denomination.

"Loam denotes any ſoil moderately coheſive, that is, leſs ſo than clay, and more ſo than looſe chalk; by the author of the Body of Agriculture it is ſaid to be a clay mixed with ſand. Dr Hill defines it an earth compoſed of diſſimilar particles, hard, ſtiff, denſe, harſh and rough to the touch, not eaſily ductile while moiſt, readily diffuſible in water, and compoſed of ſand and a tough viſcid clay. The definition I have given, ſeems moſt ſuited to the different ſpecies I ſhall now enumerate.

"Clayey loam denotes a compound ſoil, moderately coheſive, in which the argillaceous ingredient predominates; its coherence is then greater than that of pure clay; the other ingredient is a coarſe ſand, with or without a ſmall mixture of the calcareous ingredient. It is this which farmers generally call *ſtrong*, *ſtiff*, *cold*, and *heavy* loam, in proportion as the clay abounds in it.

"Chalky loam. This term indicates a loam formed of clay, coarſe ſand, and chalk; in which, however, the calcareous ingredient, or chalk, much predominates. It is leſs coheſive than clay loams.

"Sandy loam, denotes a loam in which ſand predominates. It is leſs coherent than either of the above mentioned. Sand, partly coarſe, and partly fine, forms from 80 to 90 per cwt. of this compound.

"Gravelly loam differs from the laſt, only in containing a larger mixture of coarſe ſand or pebbles. This and the two laſt are generally called by farmers *light* or *hungry* ſoils; particularly when they have but little depth.

"Ferruginous loam, or till. This is generally of a dark brown or reddiſh colour, and much harder than any

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any of the preceding. It conſiſts of clay and calces of iron, more or leſs intimately mixed. It may be diſtinguiſhed not only by its colour, but alſo by its ſuperior weight. It ſometimes effervеſces with acids and ſometimes not; when it does, much of the irony part may be ſeparated, by pouring it when well dried into ſpirit of ſalt, from which the iron may be ſeparated by alkalies or chalk.

"Akin to this are certain *vitriolic ſoils*, which, when ſteeped in water, impart to it the power of reddening ſyrup of violets. Theſe are generally of a blue colour, but redden when heated.

"Boggy ſoil, or bogs, conſiſt chiefly of ligneous roots of decayed vegetables mixed with earth, moſtly argillaceous, and ſand, and a coaly ſubſtance derived from decayed vegetables. Of bogs there are two ſorts: the black, which contains a large proportion of clay and of roots more perfectly decayed, with mineral oil; in the red, the roots ſeem leſs perfectly decayed, and to form the principal part.

"Heathy ſoil, is that which is naturally productive of heath."

Though not properly a kind of ſoil, yet, as uſed for the purpoſe of improving other ſoils, we may here take notice of the deſcription given by the ſame writer of what is called *marl*. "Marl is of three ſorts, calcareous, argillaceous, and ſiliceous or ſandy. All are mixtures of mild calx (i. e. chalk) with clay, in ſuch a manner as to fall to pieces by expoſure to the atmoſphere, more or leſs readily.

"Calcareous marl is that which is moſt commonly underſtood by the term *marl without addition*. It is generally of a yellowiſh white, or yellowiſh gray colour;

rarely brown or lead coloured. It is ſeldom found on the ſurface of land, but commonly a few feet under it, and on the ſides of hills or rivers that flow through calcareous countries, or under turf in bogs, frequently of a loſe texture, ſometimes moderately coherent, rarely of a ſtony hardneſs, and hence called *ſtone-marl*; ſometimes of a compact, ſometimes of a lamellar texture, often ſo thin as to be called *paper-marl*. It often abounds with ſhells, and then is called *ſhell-marl*, which is looked upon as the beſt ſort. When in powder, it feels dry between the fingers; but in water, it quickly falls to pieces or powder, and does not form a viſcid maſs. It chips and moulders by expoſure to the air and moiſture, ſooner or later, according to its hardneſs and the proportion of its ingredients. If heated, it will not form a brick, but rather lime. It efferveſces with all acids. It conſiſts of from 33 to 80 per cwt. of mild calx, and from 66 to 20 per cwt. of clay.

“ To find its compoſition, pour a few ounces of weak, but pure, ſpirit of nitre or common ſalt, into a Florence flaſk; place them in a ſcale, and let them be balanced; then reduce a few ounces of dry marl into powder, and let this powder be carefully and gradually thrown into the flaſk, until, after repeated agitation, no efferveſcence is any longer perceived; let the remainder of the powder marl be then weighed, by which the quantity projected will be known: let the balance be then reſtored; the difference of weight between the quantity projected and that requiſite to reſtore the balance, will diſcover the weight of air loſt during the efferveſcence; if the loſs amounts to 13 per cwt. of the quantity of marl projected, or from 13 to 32 per cwt. the marl eſſayed is calcareous marl.

This experiment is deciſive, when we are aſſured by the external characters above mentioned, that the ſubſtance employed is marl of any kind; otherwiſe, ſome ſorts of the ſparry iron-ore may be miſtaken for marl. The experiments to diſcover the argillaceous ingredient, being too difficult for farmers, I omit. The reſidue left after ſolution being well waſhed will, when duly heated, generally harden into a brick.

"Argillaceous marl contains from 68 to 80 per cwt. of clay, and conſequently from 32 to 20 per cwt. of aerated calx. Its colour is gray, or brown, or reddiſh brown, or yellowiſh or bluiſh gray; it feels more unctuous than the former, and adheres to the tongue; its hardneſs is generally much greater; in water it falls to pieces more ſlowly, and often into ſquare pieces; it alſo more ſlowly moulders by expoſure to the air and moiſture, if of a looſe conſiſtence; it hardens when heated, and form an imperfect brick; it effervesces with ſpirit of nitre or common ſalt, but frequently refuſes to do ſo with vinegar; when dried and projected into ſpirit of nitre, in a Florence flaſk, with the attentions above mentioned, it is found to loſe from 8 to 10 per cwt. of its weight. The undiſſolved part well waſhed, will, when duly heated, harden into a brick.

"Siliceous or ſandy marls are thoſe whoſe clayey part contains an exceſs of ſand; for, if treated with acids, in the manner above mentioned, the reſiduum or clayey part will be found to contain above 75 per cwt. of ſand; conſequently chalk and ſand are the predominant ingredients.

"The colour of this marl is browniſh gray or lead colour; generally friable and flaky, but ſometimes forms very hard lumps; it does not readily fall to pieces in water; it chips and moulders by expoſure to the air and moiſture, but ſlowly; it effervefces with acids, but the reſiduum after ſolution will not form a brick.

« Lime-ſtone gravel. This is a marl mixed with large lumps of lime-ſtone; the marl may be either calcareous or argillaceous, but moſt commonly the former; the ſandy part is alſo commonly calcareous."

We ſhall diſcuſs particularly the ſpecial modes of ameliorating, by proper mixtures and additions, theſe ſeveral kinds of ſoil, when we come afterwards to treat of the practical preparation and uſe of manures in huſbandry.

SECT. V.

OF THE DIFFERENT KINDS OF VEGETABLES PROPER TO BE RAISED WITH A VIEW TO THE MELIORATION OF SOIL.

Soil improved by pulverization.

THE cultivation of certain plants, when properly conducted, has a conſiderable tendency to increaſe the fertility of the ſoil. In ſuch a caſe the farmer enjoys the ſatisfaction of meliorating his lands, and of reaping crops at the ſame time.

One very conſiderable ſtep towards the melioration of ground is its pulverization. This is uſually accompliſhed by repeated ploughings, and more particularly by the uſe of ſummer fallow; which latter practice conſiſts of allowing the ſoil to remain without a crop for a whole ſeaſon, and during that time of repeatedly turning it over with the plough,

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plough. In the French huſbandry, as already mentioned, to this day, the ſummer fallow is almoſt the only reſource that is employed to render the ſoil capable of bearing ſucceſſive crops of grain; and the ſame practice anciently prevailed in our own country, and even continues to prevail to a great extent.

Uſes of ſummer fallow.

It is undoubtedly true, that under a rotation, conſiſting of ſummer fallow and crops of grain alternately, the land has not been found to improve; but, it is alſo true, that upon certain ſoils, when the cropping was not ſevere, the land continued, with little other aid than that of ſummer fallow, to produce grain during a great length of time, without any ſenſible deterioration. The benefits which the uſe of fallow confers upon the ſoil, or the advantages which the huſbandman derives from it, appear to be chiefly theſe: it pulverizes, cleans, and manures, the ſoil. In the firſt place, as already mentioned, it pulverizes the ſoil, and breaks that tenacity of parts which, in its rude ſtate, it naturally acquires, and thereby enables the roots of delicate plants to pervade it freely in all directions in queſt of their natural nouriſhment. From the nature of the thing, however, it is obvious, that repeated ploughings (eſpecially when performed in autumn, with a view to expoſe the ſoil to the pulverizing effects of the winter's froſt), muſt be chiefly valuable upon lands of a ſtiff and adheſive texture, and that upon light and ſandy ſoils it will be leſs neceſſary. Accordingly it has been found by experience, that ſuch ſoils have been very perceptibly injured by too frequent ploughings. It is no doubt true, that all plants require a certain openneſs to be preſerved in the earth around their roots, that they may be enabled to puſh out with advantage; but it is alſo neceſſary that the ſoil ſhould poſſeſs ſuch a degree of firmneſs as may enable it to retain, for a ſufficient length of time, the moiſture requiſite for the ſupport of vegetation; and, at the ſame time, afford a ſteady ſupport to the ſtems of the plants which grow upon it.

The ſecond uſe of ſummer fallow conſiſts of its tendency to clear the ground from thoſe other plants which we wiſh to deſtroy for the purpoſe of making room for the vegetables that we would wiſh to rear, as moſt valuable for the ſupport of men or cattle. The deſtruction of noxious plants is accompliſhed by ſummer fallowing in two ways: 1ſt, By its effect upon the roots of ſuch plants; and, 2dly, by its effects upon the ſeed. Nature has provided very carefully and effectually for the preſervation of moſt of her vegetable productions, by rendering them capable of propagating themſelves in two ways—either by the ſeed, or, if that is not ſuffered to arrive at maturity, by putting forth new ſtems from the roots. By means of ſummer fallow both theſe modes of reproduction are, in ſome meaſure, counteracted. The roots of the plants we wiſh to deſtroy being turned up, and expoſed to the action of the ſun and air, are rendered unfit for vegetation. The ſeeds of plants are in general ſo well protected by the kind of covering in which they are enveloped, as to remain long indeſtructible by expoſure to the air; but, being ſuffered to vegetate, and at the ſame time ploughed down before they are allowed to ripen or bring forth new ſeed, they alſo are deſtroyed by the frequent ſtirring of the land for which a ſummer fallow affords an opportunity.

A third and laſt advantage derived from ſummer fal-

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low, conſiſts of its effect in ameliorating or enriching the ſoil. That the uſe of ſummer fallow muſt confer ſomething nutritive, or ſome kind of manure upon the land, ſeems demonſtrable. During the old ſyſtem of huſbandry, many ſoils received little other amelioration that what they derived from a ſummer fallow; yet for ages they continued to produce a certain quantity of grain, which was carried off from the lands, and conſumed at a diſtance, without any care being taken to give to the ſoil a compenſation for what it had thus loſt. While this practice prevailed, it was found that no number of ploughings, even where the land was tolerably clean, could produce the effect of a ſummer fallow, or enable the land to bear a tolerable crop without the kind of amelioration which that practice conferred.

That a ſummer fallow tends actually to enrich, or, in the ſtrict ſenſe of the word, to add manure to the ſoil, ſeems obvious. By expoſing to the air the roots of the various plants, whether of natural or artificial growth, with which the ſoil abounds, it converts theſe roots into a ſource of new fertility. By the action of the air and of light they ſuffer a chemical decompoſition, which is analogous to fermentation, and which ends in the production of a portion of fertile ſoil or garden mould. It is probably in conſequence of this change which the roots of plants undergo, or their rotting, that land turned up by the plough ſoon acquires a darker colour than it formerly poſſeſſed.

It does not appear, however, that the manure obtained in this way from the decayed roots of vegetables, will entirely account for the fertilizing effects of a ſummer fallow, or that a ſufficient compenſation is thus made to the ſoil for what is loſt by a previous crop. It

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is probable, therefore, that *the earth itſelf when turned up, attracts or abſorbs from the light, and from the air ſome fertilizing principles. We are ſtill too little acquainted* with the laws which govern the circulation of the different elements of nature, to be able to explain preciſely and clearly the kind of change which is thus operated. It is certain that all putrid effluvia are rapidly abſorbed, or putrid ſuſtances deprived of their ſmell, by freſh earth or mould; and it is probable that as cultivated countries are the moſt healthful, the ſoil when newly ſtirred or turned up, has a tendency ſpeedily to withdraw from the atmoſphere all bad air, or the great quantities of volatile or carbonaceous matter thrown into it by the reſpiration of animals or artificial combuſtion.

The practice of ſummer fallow, however, for the purpoſe of ameliorating the ſoil, is attended with immenſe diſadvantages. That a third or a fourth of the whole arable territory of a ſtate ſhould annually remain not merely unproductive, but a ſource of expence from the frequent ploughings it requires, is undoubtedly a very ſerious evil;—to landlords, as occaſioning a proportional inferiority of rent; to farmers, as leſſening the profit of their occupation; and to the nation, as implying a ſlender population, in conſequence of the ſcantineſs of the produce of its territory. Hence it has always appeared an important object in agriculture, to diminiſh as far as poſſible the quantity of fallows, without injuring the productive energies of the ſoil. Here modern huſbandry enjoys one of its greateſt triumphs over ancient practices, by introducing certain crops, which perform to the land and to the huſbandman the three ſervices already aſcribed to fallows, of pulverizing, cleaning,

ing, and manuring the ſoil, while at the ſame time a great additional quantity of food is produced for man or cattle.

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By planting in the field thoſe vegetables whoſe roots ſwell to a conſiderable bulk, the ground muſt conſtantly be acted upon by the ſwelling of their roots in all directions: and thus the growing of the crop itſelf may be equal, or ſuperior, in efficacy to ſeveral ploughings, at the ſame time that the farmer enjoys the benefit of it. The plant moſt remarkable for the ſwelling of its roots is the potato, though it undoubtedly exhauſts the productive powers of the ſoil in a very great degree. Potatoes are not, however, equally proper for all ſoils. In clay they do not thrive, nor are palatable; but in gravelly or ſandy ſoils, they grow to a large ſize, and are of an excellent quality. Turnips likewiſe contribute to looſen the ſoil by the ſwelling of their roots, though not ſo much as potatoes. They have this advantage, however, that they will thrive in almoſt any ſoil. In clay ground, peaſe and beans thrive exceedingly well, and therefore are proper in this kind of ſoil as a preparatory for other kinds of grain. Theſe puſh their roots deep into the ground, and cover it with their leaves more than other crops; ſo that the ſun has not ſo much acceſs as when it is covered with other kinds of grain. Wherever any of theſe kinds of vegetables are raiſed, it is obſervable, that more or leſs blackneſs is communicated to the ſoil: an evident ſign of its melioration; this being the colour of the true vegetable mould, or rich *loamy ſoil*, as it is often called.

Beſides the above-mentioned plants, carrots, parſnips, cabbages, and all thoſe vegetables which ſink their roots deep into the ground, anſwer the ſame purpoſe of looſening

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looſening and pulverizing the earth: but as they will not thrive but on ground already well cultivated, they cannot be raiſed to any advantage upon a poor ſoil.

Moſt of the ſame vegetables, by means of the drill huſbandry, that is, by being planted in rows which admit the earth to be freely ſtirred by the plough about their roots while the plants are growing, afford an opportunity of clearing the ſoil of weeds to no leſs advantage than can be obtained by the coſtly operation of a ſummer fallow. Nay it is even found, that while one farmer, by means of theſe green crops, frequently ploughed in the intervals, or between the rows, reduces his lands to the ſtate of a garden, both in point of pulverization and cleanneſs, his neighbour, truſting to the old ſummer fallow, in ſpite of all his labour and expence, finds annual weeds gaining ground upon him apace, and has no other reſource than that of laying down his fields to graſs for ſome years.

When the plants already mentioned are uſed upon a farm inſtead of fallow, and when they are employed for feeding cattle, they afford an opportunity of ameliorating the ſoil in a far higher degree than could ever be accompliſhed by means of ſummer fallow. If the dung thus produced is properly managed, it not only prevents the deterioration of the moſt ordinary ſoil, but gradually carries it forward in a ſtate of progreſſive improvement, and it is only by the extenſion of the ſyſtem of raiſing green crops or crops of roots inſtead of fallow, and by feeding cattle upon the farm with the produce, that we can expect to ſee the diſtinction between what is called in-field and out-field land completely aboliſhed, and the whole arable waſte lands of the kingdom profitably brought under the plough.

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It has been cuſtomary in many places, particularly in England, to ſow turnips, peaſe, buck-wheat, &c. and then to plough them down for manuring the land. This being ſimilar to that operation of nature by which ſhe renders uncultivated ſoils ſo exceedingly fertile, cannot fail of being attended with ſingular advantages; and might be looked upon as preferable even to driving dung on the land to fatten it, were it not attended with the entire loſs of a crop for that year.

Attempts have indeed been made to avoid the loſs of a crop in ſuch caſes. Theſe attempts well deſerve the attention and approbation of agriculturiſts, and we regret that their general practicability has not yet been ſufficiently eſtabliſhed in our climate. A correſpondent of Mr Young* tried ſucceſsfully to raiſe a crop of turnips after ploughing down a crop of buck-wheat which had been raiſed during the ſame ſeaſon. "This year I have the pleaſure to inform you, (ſays this gentleman, Colonel Vavaſour), that I have made trial of turnips after buck-wheat ploughed in on the ſecond week of July. The buck-wheat was ſown the ſecond week of May, upon four acres of very light land that had been marled the former ſummer. The turnips are a very good crop; I think the beſt in our neighbourhood.

"The making turnips ſucceed buck-wheat ploughed in I moſt earneſtly recommend to farmers on light land who have a difficulty in procuring manure; and upon ſtrong heavy lands that have been long under the plough, and ſubjected to the old huſbandry, viz. two crops and a fallow.

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* *Annals of Agriculture*, vol. xxxii.

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"I do not know any crop like buck-wheat ploughed in as a preparative *for winter corn: I have a field o ſtrong land under this huſbandry of wheat ſown the end of* September after buck-wheat ploughed in. At preſent its appearance promiſes to be a good crop; and it ſeems to me reaſonable, that a heavy crop of vegetable matter ploughed into land that has been long under tillage in the old way of huſbandry above mentioned, muſt greatly refreſh the ſoil. A heavy crop of buck-wheat is certain to be procured on ſtrong clay land well pulverized in the month of June, provided the ſummer proves tolerably dry after the ſeed is ſown.

"And now, after recommending turnips on buck-wheat ploughed in, I do not know a better way to lay down light land to permanent graſs, than to let buck-wheat in the month of June, with graſs ſeeds, follow turnips. I mean the roota baga, which will remain good for ſheep all the month of May, or longer, if other proviſion ſhould be ſcarce.

"I laid down a field three years ago to permanent graſs with buck-wheat ſown the end of June and harveſted the end of September. This mode has many advantages which muſt occur to every practical farmer. The graſs ſeeds came up well."

In addition to this, it may be proper to remark, that an idea has been entertained with regard to the ſucceſſion of vegetables to each other, which ought not to be overlooked, as at ſome future period it may lead to important conſequences. It has been ſuppoſed, that the roots of plants, or at leaſt of ſome plants, poſſeſs a power of throwing out, as excrementitious, a part of the ſubſtances which they have taken in, but which are no longer neceſſary for their ſubſiſtence or growth.

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It is undoubted, at leaſt, that while by ſome plants *the ſoil ſeems to be rendered altogether unfit for the production of certain others, it is rendered by different* plants extremely well adapted to their growth. Thus wheat ſucceeds uncommonly well after drilled beans; and theſe two vegetables have even been repeated for a great number of years in rotation, without any deficiency or failure of crop.

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SECT. VI.

OF DESTROYING WEEDS.

WHAT we have already ſaid regarding the cultivation of the ſoil, reſpects only the fitting it for producing all kinds of vegetables indiſcriminately. Experience, however, ſhows, that the ground is naturally much more diſpoſed to produce and nouriſh ſome kinds of vegetables than others; and thoſe which the earth ſeems moſt to delight in, are commonly ſuch as are of very little uſe to man; but if neglected, will increaſe to ſuch a degree, as entirely to deſtroy the plants intended to be raiſed; or at leaſt hinder them from coming to perfection, by depriving them of nouriſhment. The clearing the ground of weeds, therefore, is an article no leſs neceſſary in agriculture, than the diſpoſing it to produce vegetables of any kind in plenty.

Weeds divided into annual and perennial.

Weeds may be divided, according to the time of their duration, into *annual*, or ſuch as ſpring from a ſeed, and die the ſame year; and *perennial*, that is,

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ſuch as are propagated by the ſeeds, and laſt for a number of years. The firſt *kind are the leaſt noxious, and moſt eaſily deſtroyed. For this purpoſe it will be ſufficient to let them ſpring up till near the time of ripening their ſeed, and then plough them down before it comes to maturity. This was formerly done by* means of a ſummer fallow, as already mentioned, but may be performed more advantageouſly by green crops carefully horſe-hoed. It is alſo of ſervice to deſtroy ſuch weeds as grow in borders or neglected corners, and frequently ſcatter their ſeeds to a great diſtance; ſuch as the thiſtle, dandelion, rag-weed, &c. for theſe are ſufficient to propagate their ſpecies through a deal of ground; as their ſeeds are carried about with the wind to very conſiderable diſtances. A farmer ought alſo to take care, that the ſmall ſeeds of weeds, ſeparated from corn in winnowing, be not ſown again upon the ground; for this certainly happens when they are thrown upon a dunghill; becauſe, being the natural offspring of the earth, they are not eaſily deſtroyed. The beſt method of preventing any miſchief from this cauſe, would be to burn them.

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Perennial weeds cannot be effectually deſtroyed, but by removing the roots from the ground, which is often a matter of ſome difficulty. Many of theſe roots ſtrike ſo deep in the ground, that they can ſcarcely be got out. The only method that can be depended upon in this caſe, is frequent ploughing, to render the ground as tender as poſſible; and harrowing with a particular kind of harrow, which ſhall hereafter be deſcribed, in order to collect theſe pernicious roots. When collected, they ought to be dried and burnt, as the only ef-

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fectual method of enſuring their doing no further miſchief.

There is a particular ſpecies of weed, peculiar only to graſs lands, of a ſoft ſpongy nature, called *fog*, which *it is found very difficult to exterminate.*

Nature of fog.

What is vulgarly called fog uniformly conſiſts of one or more ſpecies of what are properly denominated the moſs plants. The nature of theſe plants, and conſequently of fog, will be fully explained when we come to treat of the ſubject of moſſes, and their improvement. In the mean time it may be remarked, that the moſs plants are extremely hardy in their nature, and grow up readily upon poor ſoils in all ſuch cold and bleak ſituations as are unfit for the permanent production of more delicate plants. When lands, therefore, have been laid down to graſs in a poor and exhauſted ſtate, the graſſes die out in a few years, and their place is occupied by various ſpecies of the hardy moſs plants under the denomination of fog, which is unfit for the ſuſtenance of cattle. The proper mode of exterminating this weed upon arable lands conſiſts of uſing the plough for the purpoſe of putting them under one or more crops of turnips. If the turnips are eaten upon the field by cattle or ſheep, the ſoil will neceſſarily be enriched by their dung, but if theſe roots are conveyed to cattle intended to be ſtall-fed, the cattle's dung ought to be entirely laid upon the field. In either caſe the ſoil thus enriched may again be laid down to graſs.

In the caſe of high or upland paſtures that are not arable, the beſt mode of permanently deſtroying fog or the moſs plants, and of encouraging the growth of the more delicate graſſes, conſiſts of improving the climate by belts of planting, and at the ſame time of ſpreading upon the ſurface of the ſoil quick-lime, which is a deadly foe to all the moſs plants, and *conſequently to fog.*

Mr Young* mentions a *mode of temporarily deſtroying fog, which deſerves notice on account of the facility of the practice, and the advantages with which it is* attended.

"Many years paſt, (ſays this author), the late Reverend Mr Lord of Welnetham, in Suffolk, practiſed a huſbandry which I have often heard farmers condemn; it was that of keeping for winter uſe the whole crop of graſs. I have ſeen him thus preſerve what would in July have produced two tons of hay per acre. I did not then approve the practice, and urged theoretically, that the plants perfecting their ſeeds, and ſtanding long after, muſt become mere ſtraw, and of no value; he replied that it ſhould be what I pleaſed to call it *ſtraw*, if I would have it ſo; but that he found this ſtraw mixed, as it will be, with a young growth, better than hay. I once ordered a field to be kept in like manner; but my bailliff, diſliking much the experiment, in my abſence turned cattle in, and fed it the latter end of Auguſt or beginning of September. It now appears to be no uncommon practice in South Wales. The account we have of it is very curious: On uplands, ſo dry and ſound that no animal can, in the wetteſt weather, make an impreſſion on the ſurface, and naturally running to white-clover and good graſs, it is the practice to ſet apart many acres. Early in May the fields are ſhut up for the ſummer ſeaſon with no

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* *Annals of Agriculture*, vol. xxiii.

Of Deſtroying Weeds.

other attention than to cut docks and thiſtles, and thus left till December, when all the ſtock is turned in, and all ſorts are kept in excellent condition without any hay, ſtraw, or other food; and the butter thus gained as good as in any part of the year. The froſt ſweetens *the graſs, and ſnow does not injure it; but while it is buried, dry food is given. Early in ſpring there is* under this ſhelter a great growth of young graſs; and both together eaten with avidity. Moſs is thus cured, and diſappears without the aid of the plough or manure. It betters every year; and the beſt acre of hay will not keep more ſtock, or in ſuch good condition, as an acre of fog. The fields are found to be much improved by the quantity of ſeeds that fall. It appears that the practice is found in the weſt riding of Yorkſhire; but they do not train up till the beginning of July."

Broom, furze, &c. how deſtroyed.

Beſides theſe kinds of weeds, which are of an herbaceous nature, there are others which are woody, and grow to a very conſiderable ſize; ſuch as broom, furze or whins, and thorns. *Broom* is an evergreen ſhrub, that thrives beſt in a ſandy ſoil; and there it grows ſo vigorouſly, as ſcarcely to admit any graſs under it. It propagates by ſeed which grows in pods; and theſe, when fully ripe, break with violence, ſcattering the ſeeds all around. Thus, a field which is overgrown with broom, beſides the old plants, always contains an infinite number of young ones: ſo that though the old plants die when cut over, a freſh crop conſtantly ſprings up. It may, however, be deſtroyed by frequent ploughing and harrowing, in the ſame manner as other perennial weeds are; for it does not for ſome time carry any ſeed, and the frequent ploughing encourages the vegetation of all thoſe ſeeds that are already in the

ground,

Of Deſtroy-ing Weeds.

ground, which cannot fail of being deſtroyed by frequent repetitions of the operation. Another method of deſtroying broom, is by paſturing the field where it grows with ſheep. A few of the old buſhes may be left as a ſhelter, and theſe will be in a good meaſure prevented from ſpreading by the cropping of the ſheep. Theſe animals are very fond of broom, and greedily devour every young ſhoot; ſo that if any remain after the firſt year, there will not be a veſtige the ſecond. If this method of extirpating broom is equally effectual with that of frequent ploughing, it is certainly much more profitable, as there is no food more nouriſhing to ſheep than young broom. Broom, however, is ſaid to have a ſingular effect upon ſheep: it makes them drunk ſo effectually, that when heated with a little driving, they tumble over, and lie without motion.

The *whin* is a fine evergreen ſhrub, carrying a ſweet-ſmelling flower all the year round. It propagates both by ſeed and by its roots, which ſpread ſometimes to the diſtance of 10 or 12 feet; and hence, when once eſtabliſhed, it is with difficulty extirpated. The beſt method is to ſet fire to the whins in froſty weather; for froſt has the effect to wither whins, and make them burn readily. The ſtumps muſt then be cut over with a hatchet: and when the ground is well ſoftened by rain, it may be ploughed up, and the roots taken out by a harrow adapted to that purpoſe. If the field is ſoon laid down to graſs, the whins will again ſpring up in great abundance from the ſeeds, and ſmall parts of the roots left in the ground. In this caſe, paſturing with ſheep is an effectual remedy; as they are no leſs fond of young whins than of young broom; and if there are a ſufficient number, they will not leave a ſingle

plant

Diſeaſes of Plants.

plant above ground. But if graſs is not immediately wanted, the moſt effectual method of clearing a field of whins, is by reiterated ploughings.

The *thorn*, or *bramble*, ſpreads its roots very wide, and at the ſame time ſinks them deep in the earth. Though cut in the winter, it riſes, and comes to ſuch perfection as to carry fruit in ſummer. It can only be extirpated by ploughing up the ground, and collecting the roots.

Shrubs are deſtroyed by flooding the land.

One effectual plan, which, as will afterwards appear, is practicable in many more ſituations than it has hitherto been applied to, for deſtroying theſe and all other woody ſhrubs and plants, together with a great number of weeds that are of no value upon paſture grounds, conſiſts of flooding the land, by directing over it a ſtream of water. By means of ſuch a device, all whins and other ſhrubs are completely rotted and deſtroyed.

SECT. VII.

OF THE DISEASES OF PLANTS.

The diſeaſes of vegetables are ill underſtood.

As ſome of the moſt valuable kinds of vegetables are liable to ſuffer much by diſeaſes peculiar to themſelves, it is of much importance to the huſbandman to be aware of this circumſtance, and to adopt every known mode of protecting his crop againſt them. At the ſame time, as the principles of vegetable life are by no means well underſtood, the cauſes and the cure of the moſt ſerious diſeaſes affecting plants ſtill remain under a great degree of obſcurity, and the moſt experienced and intelligent huſbandmen expreſs great uncertainty reſpecting the meaſures to be adopted for preventing their appearance. Hence it ſeems moſt proper, to introduce the conſideration of them in this place before we proceed to the practical part of the ſubject; and as wheat is accounted the moſt valuable kind of grain, we ſhall begin with the diſeaſes to which it is expoſed.

Wheat chiefly ſuffers from two diſeaſes, the blight and the mildew. Of the blight in wheat we ſhall give an account upon the authority of an eſſay by Robert Somerville, Eſq. ſurgeon, 1ſt Battalion, 8th Fencible Regiment, inſerted in the communications to the Board of Agriculture *, giving a ſtatement of the nature and appearance of the blight which occaſioned the failure of the crop in 1795. When the crop had juſt ſhaken the flowers, and the grains were beginning to form, moſt of them ſeemingly in a healthy manner, it was obſerved that many of the blades and ſtalks were rather of a dirty green colour, and in two weeks thereafter there appeared upon them great numbers of ſmall red inſects. As the ſeaſon advanced, theſe inſects not only increaſed in ſize, but became more numerous, and in almoſt every field the grain began to manifeſt unequivocal ſymptoms of diſeaſe, which were ſo formidable, that, in many inſtances, a total loſs was dreaded, and, in not a few caſes, one half of the crop was actually deſtroyed. The minute ſymptoms of the blight were theſe:

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* Vol. ii.

Diſeaſes of Plants.

1ſt, In the very early ſtages of the diſeaſe, and before the ear was affected, the blades and ſtalks were marked with black and ruſty ſpots. Theſe ſpots ſeemed to be occaſioned by a glutinous ſubſtance depoſited upon them, eaſily ſoluble in water, and which could be readily waſhed off by rubbing the ſtalks with a wet cloth. Some ſpots, however, were white, and theſe ſeemed to be owing to wounds or punctures made by vermin; the leaf having, to a certain extent, in conſequence of theſe, withered and become white. As the ſeaſon advanced, the black and ruſty-coloured ſpots became larger and more numerous: and when the grain began to ripen, not only the blades but the ſtraw were almoſt entirely diſcoloured with black ſpots.

2d, After the crop had begun to ſhoot, and was in the ear, many of the heads were entirely empty. Where the ſtalk was green, and to appearance tolerably healthy, but the ear at the ſame time withered and without grain, the misfortune ſeemed to have ariſen from an injury done to the neck of the ear, at the place of its junction with the ſtalk. There the outer rind was deſtroyed all round, which muſt have cut off the circulation between the ear and the ſtalk, as happens in trees that have had their bark deſtroyed all round.

3d, Many of the ears were entirely empty in the upper part, while the lower half was well filled. In theſe caſes, the injury ſeemed owing to the rind being deſtroyed about the middle of the ear, at that place which ſeparated the full from the empty part, and was ſimilar to the injury done in the preceding caſe where the whole ear was deſtroyed.

4th,

Diſeaſes of Plants.

4th, In very many caſes the ears had a plump well-filled pickle and an empty huſk alternately. In theſe the injury ſemed owing to a wound inflicted at the bottom of the empty grains, where they are joined to the ſtalk, and which had taken place while they were in flower, preventing them from making any farther progreſs.

5th, Many ears, though not entirely empty, contained only ſmall ſhrivelled grains, or what are called *hungry pickles*. Theſe ſeemed to have eſcaped any accident till they had made ſome progreſs in filling, after which they became ſtationary and ripened prematurely. On examination they were found to be injured at the place where they were joined to the ſtalk, in the ſame manner as was already mentioned, in the caſe of thoſe that had empty heads or ears. Like theſe alſo the whole ear was in ſome caſes ill-filled. In others only half of it was in that ſtate, and in a very great number the ears conſiſted of a well and ill-filled grain alternately. Without a ſingle exception, the whole of the ill-filled or hungry grains, were wounded at the place of their inſertion into the ear.

6th, A number of ears, though well-filled, were, upon opening the huſks, found almoſt entirely covered with black and ruſty ſpots, nearly reſembling thoſe already deſcribed, and like them alſo they were eaſily rubbed or waſhed off. The downy part of many of theſe grains, when examined carefully with a good glaſs, appeared to contain ſeveral ſmall white tranſparent globules, reſembling the eggs of inſects.

7th, In many fields, eſpecially ſuch as had been fallowed and well manured for the wheat crop, a great number of plants were entirely withered from top to bottom.

Diſeaſes of Plants.

bottom. The decay, in moſt of theſe caſes, took place when the wheat was beginning to ſhoot. No injury was viſible in theſe caſes upon the blade or ſtalk, but on examining the roots, a worm was found at every one of them.

Laſtly, As the crop began to whiten, the dark or ruſty ſpots on the ſtraw and ears became more numerous, and appeared more conſpicuous. In place of putting on a white or yellow appearance, the whole crop looked as if it had been ſprinkled with ſoot.

The whole of theſe ſymptoms appeared to ariſe from the attack of an inſect, and from the injuries and depredation which it committed upon the plants. This inſect, when firſt diſtinguiſhable by the eye, was of a red colour, and ſo ſoft as to be killed by the ſlighteſt preſſure. As it increaſed in ſize the colour gradually changed to a dirty black, at which it became ſtationary. [illegible] it loſt its ſoft texture, and in proportion as its colour darkened it became hard, and as it were covered with a cruſt or ſhell upon the back. It is ſaid to be not uncommon, and to be met with at all times, even in the beſt fields of wheat, though its numbers are infinitely increaſed in late wet ſeaſons. From its eggs appearing to lodge upon the well-filled ears of the grain, it might be conſidered as in danger of being propagated to the ſucceeding crop. On this account our author hazards ſome conjectures upon the beſt means of preventing future danger from it. One of theſe conſiſts of the uſe of lime mixed up with all manure, with a view to prevent inſects from being generated in it. It is alſo ſuggeſted that the manure, by means of which ſlugs and worms are chiefly ſuppoſed to be produced, ought not to be ploughed into the ground

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ground in autumn, but applied as a top dreſſing in the ſpring; becauſe it is underſtood that manure, expoſed to the ſun and air, has much leſs tendency to foſter inſects, than when it is covered up in the earth.

Mildew is red or black, called *ſmut*.

Another diſeaſe, which is much more deſtructive to wheat, and much more frequently met with, is the mildew. It is of two kinds, the black and the red. In both caſes it conſiſts of a quantity of ſeemingly coarſe powerder attached to the grain in the ear, or looſely ſurrounding it; in conſequence of which it is evidently prevented from filling or arriving at perfection. The black kind of mildew is by far the moſt frequent and the moſt pernicious. It is moſt generally known in England by the name of *ſmut*, and in Scotland, by that of the *black*, both of which are ſufficiently expreſſive. Concerning the cauſe of this diſeaſe various opinions have been entertained. Dr Home, in his Principles of Agriculture and Vegetation, aſcribes it to an over luxuriancy of growth. He is of opinion, that too great an abundance of juices in a vegetable will produce diſeaſes ſimilar to thoſe occaſioned by repletion in animal bodies, viz. ſtagnations, corruptions, varices, carioſites, &c. along with the too great luxuriancy we have juſt now mentioned, which he expreſſes by "too great an abundance of water ſhoots." Hence he is induced to claſs the ſmut among diſeaſes ariſing from this cauſe, it being a corruption happening moſt in rainy ſeaſons and to weak grain. Like other contagious diſeaſes, he tells us, the ſmut may be communicated from the infected to healthful grain. As a preventive he recommends ſteeping the ſeed in a ſtrong pickle of ſea ſalt. Beſides the effect which this has upon the grain itſelf, it is uſeful for ſeparating the good from the bad; the beſt ſeed falling to the bottom, and the faulty ſwimming on the top of the liquor.

Opinions concerning the cauſe of mildew.

Independent of this notion of an over luxuriancy of growth, it may be obſerved, that two opinions have chiefly been ſupported by perſons who have ſpeculated and written on this ſubject. One opinion is, that the mildew conſiſts of a great multitude of paraſitical plants adhering to the grains of wheat, living upon it, and thereby conſuming its ſubſtance. Another opinion is, that it conſiſts of great numbers of inſects and of eggs of inſects, whoſe form is too ſmall to be diſtinguiſhable by the naked eye. The firſt of theſe opinions has been adopted by the celebrated Italian writer Fontana, and the other by certain writers of our own country.

Fontana's opinion.

Fontana endeavours to refute the hypotheſis, that the duſt of the mildew conſiſts of animal eggs, by the following experiment. He cloſely confined the grains of the mildew between two glaſs plates, in ſuch a manner as neceſſarily to break the ſuppoſed eggs. He then, with an accurate microſcope, obſerved them while cruſhed in ſucceſſion. No liquid or glutinous juice proceeded from them, though great force was uſed in cruſhing them; but they appeared wholly to conſiſt of tough reſiſting ſubſtances, altogether unlike real animal eggs: their being faſtened to the ſtalk or leaves of the grain, appeared alſo to militate againſt ſuch a ſuppoſition. From a variety of microſcopic obſervations, he is of opinion, that the powder of the black mildew or ſmut conſiſts of a great multitude of ſmall plants attached to the grain by a ſlender fibre. Theſe paraſitical plants, though extremely ſmall, he thinks

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ſufficiently regular. With regard to the red mildew he admits, that it appears to be compoſed of an immenſe multitude of minute eggs. After a variety of experiments and obſervations, however, he thought he diſcovered, that theſe apparent eggs are in truth the heads or fruit of very fine threads fixed on the ear of corn; that theſe threads or ſtems are exceedingly fine and tranſparent, which gives the appearance of eggs to their outward extremities. Theſe ſtems or tails are repreſented by him, as infinitely finer than thoſe of the black mildew; and their heads, which reſemble eggs, may be ſeparated from them by the ſlighteſt ſhock. From all his obſervations he concludes, that both the black and the red mildew conſiſt of real plants, though, perhaps, of an imperfect kind; and that they enfeeble and waſte the crop by abſorbing the nutritive juices of the plant. He obſerves, that, if a heavy rain ſpeedily fall on an extenſive mildew, waſhing the leaves and ſtalks affected, it preſently diſappears with hardly any damage to the corn; becauſe the ſmall plants having hardly taken root are eaſily diſperſed before any miſchief is done. He thinks, that the damage occaſioned by this diſeaſe may ſometimes be moderated or diminiſhed by cutting down the grain before it is fully ripe. In this caſe, he ſays, that the crop will be leſs than it ought to be; but ſtill it will be conſiderably greater than if the cuſtomary time of harveſt is waited for, when the diſeaſe will have leiſure to produce greater miſchief.

In our own country, and particularly by Mr Somerville, in the eſſay already quoted, the ſmut in wheat has been regarded as conſiſting of a great variety of inſects. He alſo founds his opinion upon microſcopic

obſervations,

obſervations, and apprehends that from them he has clearly aſcertained the exiſtence of the inſects; and he thinks that the diſeaſe is communicated to other grain by contact, in conſequence of the paſſage of the inſects. Hence he endeavours to explain the utility of ſteeping the ſeed in pickles before it is ſown, with a view to the deſtruction of ſuch inſects.

Diſeaſes of Plants.

Pickles to prevent ſmut or mildew.

It is to be remarked, that in all countries a great variety of theſe pickles has been contrived, with a view to prevent the exiſtence of ſmut in wheat, ſome of which we ſhall now mention. One of the moſt common is the ſalt pickle, conſiſting of a ſolution of common ſalt in water, of ſuch ſtrength as that an egg will ſwim in it. To the wheat, after it has been waſhed in this pickle, and the light grains removed, ſome new ſlaked lime is added, and carefully mixed with it with a wooden ſhovel, till it attain a ſufficient degree of dryneſs, in which ſtate it is committed to the earth. A pickle conſiſting of very ſtale urine has alſo been recommended to be uſed for waſhing wheat that is meant to be uſed as ſeed. It is attended with this diſadvantage, however, that if the urine is very ſtale, and if any length of time is ſuffered to elapſe, in conſequence of rain or other accidents, before the grain is ſown, its vegetative power is ſaid to be greatly injured by the corroſive quality of the volatile alkali with which ſuch urine abounds. This is more particularly the caſe when quicklime is added to the urine; as the alkali is then brought into a cauſtic ſtate.

Another pickle has been propoſed to the Board of Agriculture by the Italian phyſician, J. B. Scandella. It is prepared and uſed in the following manner: —Take of nitre, three pounds; alum, one pound; vi-ſix ounces; verdegris, three ounces; wood-aſhes, well ſifted, ſix pounds: Boil the whole in a copper with five pails of water for an hour, then remove them from the fire, and pour them into a large veſſel; then add ſixteen pails of water, in which half a buſhel of quicklime has been previouſly diſſolved: mix the whole intimately, and allow them to ſtand till they are quite cold. In this ſteep, two buſhels and a half of wheat are to be plunged, and left for about ſix hours, ſtirring it up frequently with a wooden ſhovel, and ſkimming off what riſes to the ſurface; the wheat is then to be withdrawn, and ſpread out till it is dry enough for ſowing. The proceſs is thus to be continued until the whole quantity of ſeed intended to be ſown is pickled. The above ſteep is generally ſufficient for preparing about twenty-four buſhels of wheat.

Another pickle has been recommended, * conſiſting of a decoction in water of Barbadoes aloes, tobacco, and hellebore powder. A committee of the Royal Society of Agriculture at Paris, in 1786, recommended the following pickle for the ſame purpoſe, contrived by M. Tillet †:—Pour upon 50 pounds of wood-aſhes, 900 pints of water; ſtir it well for three days, and then draw off. Waſh the black wheat in ſo many clear waters as not at laſt to dirty it. Heat the lye, ſo as juſt to bear the hand in it; ſlake in the hot lye one pound of lime to every ſeven or eight pints of it. Into the preparation dip the ſeed in baſkets many times. For want of wood-aſhes uſe potaſh, ſeven or eight pounds for 100 pints of water.

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* *Communications to the Board of Agriculture*, vol. ii.

† *Annals of Agriculture*, vol. ix.

Arſenic uſed to prevent the mildew.

In addition to theſe it may be remarked, that a ſolution of arſenic in water is made uſe of in ſome counties of England, as a pickle in which they waſh or ſteep the grain previous to its being ſown for the purpoſe of protecting the future crop againſt ſmut.

Arthur Young, Eſq. his experiments to prevent mildew.

The moſt complete ſet of experiments, however, which we have met with upon the ſubject, was made by Arthur Young, Eſq. at preſent ſecretary to the Board of Agriculture. December 7. 1787, he ſowed 14 beds with the ſame ſeed wheat as black with the ſmut as any he ever ſaw.

N° 1. Sown dry, nothing done to it.
2. Waſhed well in clean water.
3. Waſhed in lime-water.
4. Waſhed in a lye of wood-aſhes.
5. Waſhed in an arſenic and ſalt mixture.
6. Steeped in lime-water four hours.
7. Ditto in the lye four hours.
8. Ditto in the arſenic 12 hours.
9. Ditto in lime-water 12 hours.
10. Ditto in the lye 12 hours.
11. Ditto in the arſenic 12 hours.
12. Ditto in the lime-water 24 hours.
13. Ditto in the lye 24 hours.
14. Ditto in the arſenic 24 hours.

RESULT.

N° 1. Had	377 ſmutty ears.
2. Ditto	325
3. Ditto	43
4. Ditto	31
5. Ditto	28

Diſeaſes of Plants.

Nº 6. Ditto	12
7. Ditto	3
8. Ditto	1
9. Ditto	6
10. Ditto	0
11. Ditto	4
12. Ditto	0
13. Ditto	0
14. Ditto	5

Erſkine of Marr's remedy.

A propoſal has alſo been made, to deſtroy by means of heat the inſects which are ſuppoſed to propagate the diſeaſe called *ſmut* from the ſeed wheat to the future crop. The following directions for that purpoſe are extracted from the Agricultural Survey of the County of Clackmannan, by J. F. Erſkine, of Marr, Eſq. "Let the wheat be laid upon the kiln about three or four inches thick: the kiln to be heated middling ſtrong with blind coal; the wheat to continue on the kiln for 24 hours, but turned frequently. After taking it off the kiln, it muſt be allowed 24 hours to cool; during which time it muſt be frequently turned; then put it through the fanners once or twice. After the wheat has lain a few hours on the kiln, and the fire begins to have effect, a great number of very ſmall worms, formerly undiſcovered by the eye, appear on the top of the grain, and are ſoon deſtroyed by the heat. Theſe come from blacked wheat, or other corns, that could not be ſuſpected to be indifferent; or may lie in or on good wheat; which worms continuing, (when not thus killed) might conſume the corn after it is thrown into the earth, thereby checking the growth entirely, or preventing it from having the ſtrength it otherwiſe would have to bring forth

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forth a ſtrong productive ſtalk. This practice is ſaid to have been brought from Ireland, and is recommended as preferable to pickling. It might perhaps be performed with greater ſucceſs by the uſe of a kiln heated by the ſteam of boiling water, in the way already mentioned, as ſuch a kiln would inſtantly afford a fixed and known degree of heat, which could in no caſe be exceeded."

The ſubject is thus treated by a correſpondent of Mr Young [‡]. "The cauſe of ſmut-balls is ſimply this: every grain of wheat, that the *duſt* of theſe ſmut-balls ſhall touch and *adhere to*, is thereby cauſed to produce ſmut-balls, the next ſeaſon, as certain as the ſmalleſt quantity of matter put into the arm of any perſon who hath not had the ſmall-pox, cauſeth ſuch to have that diſorder. This duſt is of a very virulent nature; and wheat being extremely ſuſceptible, is liable to take the infection various ways.

"I am fully convinced, and believe that moſt of my readers will ſoon be ſo, that wheat is not liable to this diſorder, but by contagion, as is the caſe in the ſmall-pox; and to thoſe who may query from whence ſmut-balls at firſt proceeded, I think I may ſafely promiſe an anſwer to their queſtion, on their informing me of the origin of that contagious diſorder. For it evidently appears, that where men have, at their firſt entering into the farming life, had wheat for ſeed *free from ſmut-balls, and their barns*, &c. *all free from infectious matter*, and not being in the practice of unneceſſarily changing their ſeed, (as too many are) they have continued clear, whilſt perhaps ſeveral of their neighbours have been often peſtered

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[‡] *Annals of Agriculture*, vol. xxi.

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peſtered with it, although they have frequently changed their ſeed, (a part of it every year) at a great expence, giving an advanced price in the purchaſe, and having it brought from a conſiderable diſtance.

"When I firſt ſuppoſed that the cauſe of *ſmut-balls* was owing to their duſt adhering to the grains of wheat, I took four gallons of wheat which abounded with them, and rubbed all well together with my hands, by which moſt of the balls were broken, and the grains of wheat tinged with the duſt; in this ſtate it was ſown. And believing that ſomething of a *cleanſing nature* was all that is neceſſary to remove the cauſe; I took two buſhels of the ſame parcel of wheat, which, after being well winnowed, was taken to a brook and waſhed in the following manner: viz. A gallon at a time was put into a wire ſieve, which had eight bars to an inch; at firſt it was gently immerged a few times in the water, by which every ſmut-ball amongſt it was eaſily diſcovered and taken away; this being done, the ſieve was whirled round briſkly in the water for about a minute; then all being waſhed in the ſieve, and thrown into a tub with ſome water, was ſtirred round with a broom, and laſtly, put into the ſieve again, a gallon at a time, and waſhed in the brook, expecting that the remaining particles would ſink through the bottom of the ſieve, and be carried away with the ſtream.

"This was ſown in the ſame field with the former, where no different kind of manure could have the leaſt tendency to produce ſmut-balls, amongſt either this or that. But at harveſt the difference in the crops aſtoniſhed every one who ſaw them: the firſt produced as many ſmut-balls as grains of wheat, but the latter was almoſt perfectly free from them.

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" The next year, I took ſome grains of wheat which had been *rubbed out* of ears that contained both wheat and ſmut-balls, and ſowed half of them in that ſmutted ſtated; the remainder was well waſhed in water, and then ſown near the unwaſhed grains in a ſeparate drill: at harveſt the produce of the two was oppoſite; the firſt yielded exactly twenty-four ears of ſmut-balls to one ear of wheat, the other about twenty-four of wheat to one ear of ſmut-balls.

" The ſame ſeaſon, two buſhels of the under part of the heap, and the ſweepings, were waſhed and ſown like thoſe already mentioned; the produce was very ſimilar, both being nearly free from ſmut-balls."

The ſame writer adds, that from experiment he is ſatisfied, that the moſt ſmutty wheat may at once be cleaned in ſuch a manner, that it will produce grain of a perfectly ſound quality. This however, he ſays, cannot be completely accompliſhed by waſhing with cold water, on account of the defective nature of its cleanſing powers. He recommends therefore a waſh to be made of boiling water and new burned lime, to be uſed at a moderate warmth. He deſcribes the proceſs thus: " I recommend thoſe who buy wheat for ſeed, or are about to ſow ſuch as they are ſuſpicious of, to waſh it in the manner I have already deſcribed; but if waſhing in a brook is not convenient, waſh it as well as circumſtances will admit, having an eye to the end intended to be obtained, viz. to diſpoſſeſs the wheat from all infectious matter. Afterwards put it into a tub or ciſtern, and pour ſo much thin waſh, ſuch as plaiſterers make uſe of to white-waſh walls, &c. made of boiling water and new *burnt lime*, as will cover the wheat wholly for the ſpace of ſix, eight, or twelve hours; then pour it

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forth on a ſloping floor, and in a few hours it will be dry enough to ſow.

"But obſerve the neceſſary care of not making uſe of this waſh in ſo hot a ſtate as to injure vegetation; about the medium between boiling and milk or blood warm will be a proper degree, as the wheat will reduce its heat inſtantly."

After all, however, both from the reaſon of the thing, and from the concurring opinion of the moſt experienced and intelligent farmers, we think ourſelves authorized to ſay, that the huſbandman will act imprudently if he place entire and complete confidence in any one of the remedies above mentioned, to the excluſion of the others. His ſafeſt and beſt plan for procuring crops of wheat free from ſmut is probably this: In the firſt place, he ought to procure ſeed from a ſituation in which the grain has riſen abſolutely free from this diſeaſe. He ought next to exert the greateſt care in cleaning out, in the moſt anxious manner, his whole barns and their floors, and every place within doors into which his grain may come, and in which diſeaſed grain has formerly been kept: with this view it may probably be neceſſary to whitewaſh the walls with a mixture of quicklime and water, which will prove an effectual remedy. After having adopted theſe precautions, it may ſtill be neceſſary, with a view to ſecure a ſound and full crop, to plunge the ſeed into a ſtrong pickle of ſalt and water, with a view to float the lighter grains, which ought to be ſkimmed off and laid aſide for poultry, to which they may be given after being waſhed in freſh water; or at leaſt it may be proper to uſe the precaution of waſhing the ſeed in a running ſtream, or in warm lime water. No future change of ſeed will be neceſſary. Of the farmers who have adopted this judicious mode of proceeding, there is no inſtance recorded of any one whoſe crop has ſuffered by ſmut; on the contrary, they have uſually derived a conſiderable profit from becoming the furniſhers of grain for ſeed to all their neighbours.

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The want of nouriſhment in plants may be eaſily known by their decay; in which caſe, the only remedy is, to ſupply them with food, according to the methods we have already directed, or to remove from their neighbourhood ſuch other plants as may draw off the nouriſhment from thoſe we wiſh to cultivate.—In the Memoirs of the Academy of Sciences for 1728, Mr Du Hamel mentions a diſeaſe, which he calls *le mort*, that attacks ſaffron in the ſpring. It is owing to another plant, a ſpecies of trefoil, fixing ſome violet-coloured threads, which are its roots, to the roots of the ſaffron, and ſucking out its juice. This diſeaſe is prevented by digging a trench, which ſaves all the unaffected.

Diſeaſes peculiar to ſaffron.

The bad qualities, and unequal diſtribution of the juices of plants, are the occaſion of ſo few of the diſeaſes to which vegetables in this country are ſubject, that we forbear to mention them at preſent. Moſt of the diſeaſes of our plants are owing to external accidents, particularly to the depredations of inſects.—The inſects by which the greateſt devaſtations are committed in this country are, ſnails, caterpillars, grubs, and flies. The ſnails and caterpillars feed on the leaves and young ſhoots; by which means they often totally deſtroy the vegetable. Where the plants are of eaſy acceſs, theſe vermin may be deſtroyed by ſprinkling the vegetable with lime-water; for quicklime is a mortal

Vegetables deſtroyed by inſects.

Inſects deſtroyed by lime-water.

tal poiſon to creatures of this kind, and throws them into the greateſt agonies the moment they are touched with it. On trees, however, where this method cannot ſo well be followed, fumigation is the moſt proper; and, for this purpoſe, nothing is better than the ſmoke of vegetables not perfectly dry. In ſome caſes the eggs of theſe deſtroying creatures may be obſerved, and ought without doubt immediately to be taken away. On the fruit trees, as apples, pears, medlars, on ſome foreſt trees, the oak and dwarf maple eſpecially, and the white and black thorn in hedges, a kind of little tufts are to be obſerved, reſembling at firſt ſight withered leaves twiſted by a cobweb about the uppermoſt twigs or branches. Theſe contain a vaſt number of little black eggs, that, in the ſpring, produce ſwarms of caterpillars which devour every thing. To prevent this, all the twigs on which theſe cobwebs appear ſhould be taken off and burnt as ſoon as poſſible. This ought to be done before the end of March, that none of the eggs be allowed ſufficient time for hatching.

Grubs. Grubs are a kind of worms which deſtroy the corn by feeding upon its roots; they are transformed every fourth year into the beetles called *cock-chaffers may-bugs*, &c. they are very deſtructive when in their vermicular ſtate, and cannot then be deſtroyed becauſe they go deep into the ground. When become beetles, they conceal themſelves under the leaves of trees, where they ſeem aſleep till near ſunſet, when they take their flight. It is only now that they can be deſtroyed, and that by a very laborious method; namely, by ſpreading pack-ſheets below the trees in the day-time when the beetles are in their torpid ſtate, then ſhaking them off and burning them. Some time ago they made ſuch devaſtations in the county of Norfolk, that ſeveral farmers were entirely ruined by them; one gathered 80 buſhels of theſe inſects from the trees which grew on his farm. It is ſaid, that in 1574 there fell ſuch a multitude of theſe inſects into the river Severn, that they ſtopped and clogged the wheels of the water-mills.

Turnip-fly.

Turnips, when young, are apt to be totally deſtroyed by a multitude of little black flies, from thence called the *turnip-fly*. As a preventive of theſe, ſome adviſe the ſeed to be mixed with brimſtone; but this is improper, as brimſtone is found to be poiſonous to vegetables. The beſt method ſeems to be the fumigation of the fields with ſmoke of half-dried vegetables. For this purpoſe weeds will anſwer as well as any. This fumigation muſt no doubt be often repeated, in order to drive away the innumerable multitudes of theſe inſects which are capable of deſtroying a large field of turnips.

Prevented by fumigation, &c.

Some have ſuppoſed that the fly is either engendered in new dung, or enticed by it; and have therefore adviſed the manure to be laid on in the autumn preceding, by which it loſes all its noxious qualities, while its nutritive ones are retained, notwithſtanding theſe might be ſuppoſed liable in ſome degree to be exhaled by the ſun. This method is ſaid to have been aſcertained by experiments; and it is added, that another material advantage accruing from autumn manuring for turnips is, that all the ſeeds contained in the dung, and which of courſe are carried on the land with it, vegetate almoſt immediately, are moſtly killed by the ſeverity of the winter, and the few that remain ſeldom avoid deſtruction from the ploughſhare.

Various remedies againſt the turnip-fly.

The following method of ſowing has alſo been recommended as a preventive of the fly:—" About midſummer, take the firſt opportunity when it rains, or there is an apparent certainty of rain approaching, to ſow your turnip ſeed; if about the full moon, the better. In this caſe, neither harrow, bruſh, nor roll, after ſowing. The natural heat of the ground at that ſeaſon, and the conſequent fermentation occaſioned by copious rain, will give an aſtoniſhingly quick vegetation to the ſeed, which in a few days will be up and out of all danger from the fly. At all events, ſow not till it rains; it is better to wait a month, or even longer, for rain, than to ſow (merely for the ſake of ſowing about the uſual time) when the ground is parched with heat. By the ſcorching of the ſun, the oil and vegetative quality of the ſeed are exhauſted; and the few weak plants that come up will be deſtroyed by the fly before they can attain ſtrength to put forth their rough leaves. The fly infeſts the ground abundantly in dry hot weather, but does no injury in rain. The falling rain will ſufficiently waſh the turnip ſeed into the ground without harrowing it in: which, inſtead of merely covering, too often buries this ſmall ſeed at ſo great a depth, as never afterwards to get above ground."

The following remedies are alſo recommended as having often proved ſucceſsful:—A ſmall quantity of ſoot ſown over the land at their firſt appearance. Branches of elder, with the leaves bruiſed, drawn in a gate over them. Muſk mixed with the ſeed before it is ſown. And ſulphur burnt under it, after moiſtening it with water in which tobacco has been ſteeped.

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But ſhowers on the plants, as ſoon as they appear above ground, are eſteemed the beſt preſervatives. They enfeeble and kill the fly, and haſten the plants into the rough leaf, in which ſtate they are out of danger.

The ſweet ſmell of the turnip has been thought to attract the fly; upon which ſuppoſition, the remedy appeared to conſiſt in overpowering that ſmell by one which is ſtrong, fetid, and diſagreeable. Hence it has been recommended, that upon an acre of turnips ſown in the uſual way, a peck or more of dry ſoot be thrown after the ground is finiſhed, and in as regular a way as the ſeed is ſown.

It has alſo been recommended to ſow about two pounds of radiſh ſeed on every Engliſh acre ſown with turnips. The radiſhes riſe before the turnips, and entertain the fly till the turnips are out of danger. The radiſh and turnip ſeed ought to be ſown at the ſame time, and may be mixed by the ſeedman or perſon employed to ſow.

Corn-butterfly.

Some time ago an inſect, called the *corn-butterfly*, committed ſuch ravages while in its vermicular ſtate, in France, that upwards of 200 pariſhes were ruined by it; and the miniſtry offered a reward to the diſcoverer of an effectual remedy againſt this deſtroying worm. The cure which was at laſt diſcovered was, to heat the corn in an oven ſo much as not to deſtroy its vegetative power, but ſufficiently to deſtroy the ſmall worms which made their neſt in the ſubſtance of the grain, and at laſt ate out the ſubſtance ſo completely, that nothing could be got from the huſk even by boiling it in water. It is certain, that though inſects can bear a great deal of cold, they are eaſily deſtroyed by a ſlight degree of heat; nor is the vegetative power of corn eaſily deſtroyed, even when kept for a long time in a pretty ſtrong heat. This method muſt therefore be very effectual for deſtroying all kinds of inſects with which grain is apt to be infected: but care muſt be taken not to apply too great a heat; and the adjuſting of the preciſe degree neceſſary to deſtroy the inſect, without hurting the corn, will be attended with ſome difficulty. The precautions recommended when treating of the mildew in wheat, may be adopted with ſucceſs.

The curled diſeaſe in potatoes.

The curled diſeaſe in potatoes has long been a ſubject of inveſtigation and experiment among farmers: and the knowledge of its cauſe and cure ſeems yet to remain a deſideratum. The *Agricultural Society* at Mancheſter, a few years ago, *offered* a *premium for* diſcovering by actual experiment the cauſe of the diſeaſe in queſtion; and a great variety of letters were, in conſequence, addreſſed to them upon the ſubject.—As theſe contain many intereſting obſervations both on the diſeaſe itſelf and the beſt methods hitherto adopted for preventing it, the following abſtract of them may not improperly be introduced in this place.

Various methods of prevention.

I. According to the writer of the firſt letter, this diſeaſe is cauſed by an inſect produced by froſt or bad keeping before ſetting; and the neweſt kinds, ſuch as have been raiſed within theſe nine or ten years, are moſt apt to curl, becauſe they will not ſtand to be kept in winter and ſpring before ſetting, as the old kinds will. In autumn 1776, he got up a bed of potatoes to lay by in winter, leaving plenty in the ground as regular as poſſible; and, before the ſeverity of winter came on, covered part of the bed with ſtraw and peaſe-haulm, and left the other part of the bed uncovered.

That

That part of the bed which was covered was quite free from curled ones; but the uncovered part produced a great many curled, owing, as the writer ſays, to froſt and ſeverity of the weather.

II. This writer had about a quarter of an acre of potatoes, well manured with cow and horſe dung, and took the greateſt care in picking the fine ſmooth-ſkinned potatoes for ſets; yet nine out of ten parts were curled. He attributes the cauſe of this diſeaſe to a white grub or inſect, which he found near the root, about half an inch long, with eight or ten legs, its head brown and hard; as, upon examining a number of the curled roots, he found them all bitten, chiefly from the ſurface to the root, which of courſe ſtopped the progreſs of the ſap, and threw the leaf into a curl. The uncurled roots were not bitten. He tried a few experiments as follow: Firſt, he put ſoot to the inſects in the rows for two days; and after that, he put lime to them for the ſame time, but they ſtill kept lively: next he put a little ſalt, which deſtroyed them in a few hours. From which he infers, that if coarſe ſalt were put into the ground at the time the land is preparing for potatoes, it would effectually cure this diſtemper.

III. In this letter, the cauſe of the diſeaſe is attributed to the method of earthing the ſtems while in cultivation; and the branch, ſtriking root into the new earthed-up ſoil, it is ſaid, produces potatoes of ſuch a nature as the year following to cauſe the diſeaſe complained of.

To prevent the diſeaſe, it is recommended to take the ſets from thoſe potatoes that have not bred any from the branch covered; or, otherwiſe, to dig the part the ſets are to be raiſed from.

IV. According to this writer, the diſorder proceeds from potatoes growing in old-tilled or worn-out ground; for though theſe potatoes may look tolerably well, yet their ſets will moſtly, if not all, produce curled potatoes.

Hence he is convinced, that no ſets ought to be uſed from old-tilled or couch-graſs land; and that, in order to have good ſets, they ſhould be procured from land that was purpoſely fallowed for them; from freſh ley land, where they are not curled; or from ley land that was burnt laſt ſpring.

To avoid the uncertainty of getting good ſets, he recommends crabs to be gathered from potatoes growing this year on freſh land free from curl, and the next ſpring to ſow them on freſh ley land; and continue to plant their ſets on freſh ley land yearly, which he is convinced will prevent the curl.

V. In 1772, this writer planted ſome potatoes by accident full nine inches deep: when taken up, many of the plants were rotted, and a few curled. He kept the whole produce for ſeed, and planted two acres with it in 1773, not quite ſix inches deep. The crop was amazingly great; and he did not obſerve any curled plants among them. In 1774, many of theſe were planted in different ſoils; yet they were ſo infected with the curled diſeaſe, that not one in twenty eſcaped. In 1775, the complaint of this diſeaſe became general. In 1776, it occurred to him that the good crop of 1773 was owing to the accidental deep ſetting of 1772; and that the reaſon why the ſame ſeed became curled in 1774, was their being ſet ſo near the ſurface in 1773; and attributes the diſeaſe to the practice of ebb-ſetting. In 1777, he took ſome potatoes from a crop that was curled the year before, and after cutting the

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ſets, left them in a dry room for a month. Half were planted in ground dug fourteen days before; the other half, having been ſteeped in a brine made of whitſter's aſhes for two hours, were alſo planted in the ſame land at the ſame time. The ſteeped ones came up ten days before the others, and hardly any miſſed or were curled. The unſteeped ones generally failed, and thoſe few that came up were moſtly curled.

He therefore adviſed as a remedy, 1. That the potatoes intended for next year's ſets be planted nine inches deep. 2. That they remain in the ground as long as the ſeaſon will permit. 3. That theſe ſets be well defended from froſt till the beginning of March. 4. That the ſets be cut a fortnight before planting. 5. That they be ſteeped, as above, two hours in brine or lye. 6. That the dung be put *over* the ſets. And, 7. That freſh ſets be got every year from ſandy ſoils near the coaſt, or on the ſhore.

P. S. At planting, the hard dry ſets ſhould be caſt aſide, for they will probably be curled. Curled potatoes always proceed from ſets which do not rot or putrefy in the ground.

VI. This writer had five drills of the old red potatoes, and four of the winter whites, growing at the ſame time in the ſame field. The drills were prepared exactly alike. Among the red not one was curled; the winter whites were nearly all curled. He ſays he has found by experience, that the red never curl.

VII. Two of the writer's neighbours had their ſets out of one heap of potatoes. They both ſet with the plough, the one early, and the other late, in the ſeaſon. Moſt of thoſe early ſet proved curled, and moſt of thoſe ſet late ſmooth; the latter on clay land.

A few roods of land were alſo planted with ſmall potatoes, which had lain ſpread on a chamber floor all the winter and ſpring till the middle of May. They were ſoft and withered; they proved ſmooth and a good crop. Middle-ſized potatoes, withered and ſoft, which had been kept in a large dry cellar, and the ſprouts of which had been broken off three times, produced alſo a ſmooth good crop.

Hence he was led to think a ſuperfluity of ſap, occaſioned by the ſeed being unripe, might cauſe the diſeaſe.

He concludes, the only ſure way to prevent the curl is, to let potatoes intended for ſeed ſtand till they are fully ripe, and to keep them dry all winter.

VIII. This writer ſet a quantity of the red potatoes, without having a curled one amongſt them. His method is, when the ſets are cut, to pick out ſuch as are reddeſt in the inſide. On digging them up at Michaelmas, he mixes none of the curled ſeed among the others. The curled are eaſily diſtinguiſhed, by their ſtalks withering two months before the reſt of the crop.

The cauſe of the curled diſeaſe he attributes to potatoes being of late years produced from ſeed inſtead of roots, as formerly. Such will not ſtand good more than two or three years, uſe what method you pleaſe. Laſt ſpring, he ſet the old red and white ruſſets, and had not a curled potato amongſt them.

On the limeſtone land about Denbigh, in North Wales, they have no curled potatoes. If this be owing to the nature of that land, perhaps lime might prevent the diſeaſe.

IX. According to this writer, all ſorts of grain wear out and turn wild if ſown too long on the ſame

land;

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land; the ſame will hold good in all ſorts of pulſe, peaſe, beans, and (as he conceives) potatoes. It generally happens, that thoſe who have moſt curled potatoes plant very ſmall ſets.

Eleven years ago he bought a parcel of freſh ſets, of the golden-dun kind, and has uſed them without change to the preſent year, without any being curled. This he principally attributes to his having always planted good large ſets.

About four years ſince, he thought of changing his ſets, as his potatoes were too ſmooth, too round, and much diminiſhed in ſize. But the curl at that time beginning to be very alarming, he continued his ſets till part of his crop miſſing laſt year, he was obliged to buy new ſets this ſpring, which, being ſmall, were curled like other people's.

He allows, that the curl has frequently happened to perſons who have uſed large potatoes for ſets; for, as all roots are not equally affected, ſome curled ones may be mixed with the reſt.

To prevent the evil, cut your ſets from clear and middle-ſized potatoes, gathered from places as clear of the curl as poſſible; preſerve them as uſual till ſpring. If any are harder, or graſh more in cutting than uſual, caſt them aſide. He would alſo recommend the raiſing a freſh ſort from the crab produced on the ſorts leaſt affected, which in Lancaſhire are the long-duns.

X. Set potatoes with the ſprits broke off, and they will (ſays the writer of this letter) be curled ones; if ſet with the ſprits on, they will not be curled. Again, take a potato which is ſprit, and cut a ſet off with two ſights: break one ſprit off, and let the other ſtay on, Diſeaſes of Plants

and ſet it; the former will be curled, and the latter will not.

When you have holed your potatoes, take them out before they are ſprit, and lay them dry until you have ſet or ſown them, and you will have no curled potatoes.

XI. This writer was at the expence of procuring ſets at fifty miles diſtance, and where this diſeaſe was not known. The firſt year's trial was ſucceſsful; the year following he procured ſets from the ſame place, but one-fifth of his crop was infected. By way of experiment, he planted ſets from roots which had been infected the year before, and ſome of theſe produced healthy plants, free from all infection.

As every effect muſt have a cauſe, he ſuppoſed it might be ſome inſect, which, living on the leaves, gave them that curled and ſickly appearance, as is the caſe in the leaves of many ſhrubs and trees. But whether the inſect is lodged in the old ſets, and to be deſtroyed at the time of planting, or, proceeding from ſome external cauſe, can only be deſtroyed afterwards, he is not yet certain, although he has made the following experiments.

On a piece of ground that had not been dug for 20 years, he planted four rows of ſets, which he knew to be perfectly clear; the drills were two feet diſtant, the ſets one foot diſtant in each drill. He then planted on the ſame ground four rows with ſets from curled potatoes, at equal diſtances; in each row were about 20 ſets.

Lot 1ſt, The curled ſets.

N° 1. Without manure,
2. In ſalt,
N° 3. In ſoot,
4. In quicklime.

Lot

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Lot 2d, The clear ſets.

N° 1. Without manure,	N° 3. In ſoot,
2. In ſalt,	4. In quicklime.

Thoſe planted in ſalt and ſoot in both lots were deſtroyed. In Lot 1ſt, N° 1. and 4. all curled. Lot 2d, N° 1. and 4. quite clear.

This experiment was made on a ſuppoſition that the inſect lodged in the ſet, and muſt be deſtroyed on planting. But of that he is not fully ſatisfied. He repeated ſalt, ſoot, and quicklime, on the branches of ſeveral curled potatoes. Salt deſtroyed all he touched with it. Lime and ſoot had, he thought, a partial effect on the plants. After ſome time, they appeared almoſt as healthy as the reſt. Thus, although he had done little towards the cure, he flatters himſelf he has pointed out the cauſe, the inſects on the curled plants being not only very numerous, but viſible to the naked eye.

XII. This writer aſcribes the cauſe of the diſeaſe to the froſt, and bad keeping in winter and ſpring before ſetting. They are liable to be damaged by froſt after they are ſet; but this may be prevented by covering. If it be aſked, why froſt did not injure them formerly? he anſwers, it is only the NEW kinds which are apt to curl. To this may be added, that leſs care is now taken of the ſeed than formerly. To prevent the latter, let them remain in the ground covered with haulm or litter till the time they are wanted for ſetting: and, in caſe no froſt touches them afterwards, they will be free from the diſeaſe.

XIII. This writer ſays, the red potato was as generally planted as the winter white and the Lincolnſhire kidney

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kidney are now. The firſt, being a later potato, did not ſprout ſo early as the others. The white ſprout very early, and therefore ſhould firſt be moved out of the place where they have been preſerved in the winter. Inſtead of that, they are often let remain till their roots and ſprouts are matted together. On ſeparating them, theſe ſprouts are generally rubbed off, and they are laid by till the ground is ready; during which interval they ſprout a ſecond time: but theſe ſecond ſprouts, being weak and languid, will ſhrink, ſicken, and die; and the fruit at the roots will be ſmall, hard, ill-ſhaped, and of a brown colour.

Now, if putting off the ſprouts once or more, before the ſets are put in the ground, be the cauſe (as he verily believes it is) of the curled diſeaſe, an eaſy remedy is at hand. When the potatoes intended for ſets are dug up, lay them in a weſt aſpect as dry as poſſible: in ſuch a ſituation they will not ſprout ſo ſoon. The beſt time for removing moſt ſorts, is the firſt fine day after the 24th of February. Cut them into ſets as ſoon as poſſible, and let them remain covered with dry ſand till the ground is prepared, which ſhould be a winter fallow. Lay the ſets in without breaking off any of the ſprouts, for the ſecond will not be ſo vigorous. This accounts for one ſprout out of three from the ſame ſet being curled. The two ſtems not curled roſe from two later eyes, and were firſt ſprouts. The ſprout curled was a ſecond, the firſt having been rubbed off.

XIV. This writer ſays, that laſt ſpring one of his neighbours cut and ſet, in the uſual way of drilling, ſome loads of the largeſt potatoes he could procure; and more than half of them proved curled. Being a few

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few ſets ſhort of the quantity wanted, he planted ſome very ſmall potatoes which he had laid by for the pigs. Theſe being fully ripe and ſolid, there was not a curled plant among them. He apprehends, the others being curled was owing to their not being fully ripe.

XV. Of late years, this writer ſays, great improvements have been made in ſetting potatoes and cutting the ſets. The ground is dreſſed cleaner and dunged ſtronger. Many people, in drilling, wrap up the ſets entirely in the dung; by which means, though their potatoes are larger, the diſeaſe ſeems to be increaſed. They alſo cut their ſets out of the richeſt and largeſt potatoes, which is perhaps another cauſe of this evil. In cold countries, where they ſet their own ſeed, which has grown on poor land, with leſs dung, they have no curled plants. On the contrary, when they bought rich and large potatoes for ſeed, they have been curled in great quantities. He believes, the richneſs and largeneſs of the ſeed to be the cauſe of the evil; for he does not remember to have ſeen a curled ſtem which did not ſpring from a ſet of a large potato.

XVI. This writer apprehends the curled diſeaſe in potatoes to proceed from a defect in the *planta ſeminalis*, or ſeed plant; and from comparing curled ones with others, there appeared to be a want of, or inability in, the powers of expanding or unfolding the parts of the former; which, from this defect, forms ſhrivelled, ſtarved, curled ſtems. On examining ſome of the ſets at the time of getting the crop, he found them hard and undecayed; ſo hard, indeed, that ſome of them would not be ſoft with long boiling. This led him to think, that ſome manures might have the

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ſame effect on them as tanners ooze has on leather, and ſo harden them, that the embryo plant could not come forth with eaſe; but a cloſer examination taught him otherwiſe, and that they grow equally in all manures.

He thinks the moſt conſiſtent and rational opinion is, that the diſeaſe is occaſioned by the potatoes being taken from the ground before the ſtamen, or miniature plant, is properly matured and ripened,

One of his neighbours, laſt year, ſet two rows of potatoes, which proving all curled, he did not take them up; and this year there is not a curled one among them. Such potatoes, therefore, as are deſigned for ſeed, ſhould be preſerved as long in the ground as poſſible.

XVII. This writer adviſes ſuch ſets to be planted as grow in moſs land; and, he ſays, there will not be a ſingle curled one the firſt year. This is affirmed by the inhabitants of two townſhips, where they grow amazing quantities. A medical gentleman ſowed laſt year two buſhels of ſets from one of the above places, and had not one curled; but on ſowing them again this year, he had a few.

Notwithſtanding there ſeems to be a diverſity of opinions in the above writers, occaſioned by the different appearances of their crops, and the ſeemingly contrary effects of the means uſed to prevent or cure the diſeaſe, we conceive that the following general propoſitions may be fairly drawn from the whole. 1. That ſome kinds of potatoes are (*cæteris paribus*) much more liable to be affected by the diſeaſe than the reſt; and that what are called in England the old-red, the golden-dun, and the long-dun, are the moſt free from it.—2. That the diſeaſe

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is occaſioned by one or more of the following cauſes, either ſingly or combined: 1ſt. By inſects: 2d, By froſt, either before or after the ſets are planted: 3d, From planting ſets out of large unripe potatoes: 4th, From planting too near the ſurface, and in old worn out-ground: 5th, From the firſt ſhoots of the ſets being broken off before planting; by which means there is an incapacity in the *planta ſeminalis* to ſend forth others ſufficiently vigorous to expand ſo fully as they ought.—3. That the moſt ſucceſsful methods of preventing the diſeaſe, are cutting the ſets from ſmooth middle-ſized potatoes, that were fully ripe, and had been kept dry after they were taken out of the ground; and without rubbing off their firſt ſhoots, planting them pretty deep in freſh earth with a mixture of quicklime, or on limeſtone or moſs land.

A correſpondent of the Bath Society is convinced, that, whatever may be its cauſe, the fault itſelf is inherent in the ſeed; and has communicated the following method of avoiding it: "I made a hot-bed in the following manner (which method I have uſed ever ſince): I laid horſe dung, &c. (as is generally uſed in making hot-beds), about 18 inches thick; over which I ſpread a layer of fine rich mould about four or five inches thick: upon the top of this mould I laid, in different diviſions, a certain number of potatoes of various ſorts, ſome of my own growth, and others bought from different parts, and covered theſe lightly over with more mould; they ſoon came up. I then obſerved which was freeſt from the blight or curl; for if there were not more than one defective in *forty* or *fifty*, I concluded I might ſet of that ſort with ſafety. This method I have now practiſed near twelve years, and never loſt my crop, or any part thereof worth mentioning; whilſt my neighbours, who

followed

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followed the old method, were frequently diſappointed in their crops; and to the beſt of my knowledge, all thoſe of my neighbours who have of late been perſuaded to take the trouble of uſing the ſame means as myſelf, have never failed of ſucceſs to their utmoſt wiſhes in one inſtance; nor do I ever think it will fail, if duly attended to. The fault being ſome hidden cauſe in the ſeed unknown at preſent, and I believe incurable by any means, at leaſt which have yet come to my knowledge; my reaſon for planting my hot-beds ſo ſoon is, that if the froſt hinder the firſt experiment, or they all prove bad, I may have time to make a ſecond or third, if neceſſary, with different ſorts of ſeed, before the proper ſeaſon arrives for planting in the fields and grounds appointed for the great and general crops."

In addition to the information upon this ſubject, which has been obtained by means of theſe ſocieties, various other ſpeculations about the cauſe and cure of this diſeaſe have of late been introduced to the notice of the public *. In particular it has been ſtrongly urged, that the diſeaſe is almoſt always occaſioned by inſects. It is ſaid, that on looking at the roots of ſuch potatoes as grow up curled, it will uſually be found, that the bearing plant is devoured and excavated by ſnails, centipedes, or beetles. Sometimes alſo, though more rarely, the curl is ſuppoſed to ariſe from the leaves themſelves being infected with minute animalcula. Hence, in rich ſoils in the neighbourhood of cities, and well manured gardens, the potatoes are moſt ſubject to the curl, becauſe ſuch inſects as devour the ſeed abound moſt in theſe

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* *Farmer's Magazine.*

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theſe ſoils. The inſects are thought to prefer one potato to another. They will hardly touch a yam. A potato from a late part of the country, which has been hardly ripened, the vermin do not ſeem to like; but a potato that has been ſomewhat ſweetened or mellowed by the froſt, is ſuppoſed to be greedily devoured by them.

An ingenious notion concerning the cauſe of the diſeaſe has been ſuggeſted from attending to the hiſtory of the plant in this country. The potato plant was introduced into the iſland of Great Britain from a climate much warmer than ours, as early as the reign of Queen Elizabeth; but it is a ſingular circumſtance, that the curled diſeaſe did make its appearance till within leſs than 40 years ago. Indeed *, the diſeaſe is ſaid to have firſt occurred in the year 1764, in the very diſtrict of Lancaſhire where potatoes had been firſt cultivated. It is alſo ſaid, that the Surinam potato, and ſome other kinds which have been more recently introduced into our climate, have never yet exhibited any ſymptom of the curl. It is farther ſaid, that till within theſe 40 years the potato plant never brought its ſeeds to maturity in this country, though the roots were in full perfection; that the Surinam potato and others lately introduced do not as yet produce perfect ſeeds at the top of their ſtem; and that potatoes, which have been cultivated for a length of time in bleak and mountainous ſituations, are ſtill in the ſame ſtate, and do not bring their ſeeds to maturity. Hence it is endeavoured to be inferred, that there exiſts a connexion in the nature of the plant between

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* *Tranſact. Soc. for Encouragement of Arts*, vol. viii.

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tween this diſeaſe and the ſtate of maturity to which the ſeed is brought. It is ſuppoſed, that the plant is unfit at once to afford mature and perfect ſeed at the ſummit of its ſtem, and alſo roots capable of propagating it in perfection. From theſe premiſes it is ſuggeſted, that, to prevent the curl, it will be neceſſary to procure ſeed potatoes from mountainous ſituations into which the diſeaſe has not yet come, becauſe the plant has never produced perfect fruit at the ſummit of its ſtem; or an attempt may be made to procure more perfect ſeed from the ordinary kind of potatoes, by deſtroying the flowers, which may have the effect to prevent the plant from being exhauſted by bringing to maturity both fruit at its ſummit and roots at its bottom. Laſtly, it has been ſuppoſed, upon theſe principles, that the diſeaſe may be prevented by rearing potatoes from the ſeed produced at the ſummit of the ſtem; the mode of practiſing which will afterwards be explained.

In the mean time, it may be obſerved, that the ſubject has been farther diſcuſſed, in a leſs ſpeculative manner, by an anonymous correſpondent of the Board of Agriculture *. This gentleman does not conſider the curl as a ſpecific diſeaſe, but as an accidental debility of thoſe plants in which it occurs; that we are not, therefore, to ſeek for a cure or preventive in a change of ſeed alone, as many have all along done, but in complete attention to all that experience ſhows to be neceſſary to an accurate culture, and to their perfect growth. In this way alone, he thinks, there is reaſon to expect that this very uſeful article of human food may be cultivated

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* *Communications of the Board of Agriculture*, vol. ii.

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cultivated with the ſame ſucceſs as before its dreadful enemy the curl made ſuch havoc in our crops, as of late years it certainly has done. He deſcribes the diſeaſe as occurring, in Mid-Lothian, moſt frequently from the following cauſes: 1ſt, From planting potatoes on ſoils altogether unfit for them. Being unable to penetrate a ſtiff ſoil, potatoes require a light, pervious, or open mould. For a long period after potatoes firſt appeared in the country, this circumſtance was carefully attended to. They were planted entirely with the ſpade, in the lighteſt ſpots upon every farm. Hence, the plants roſe vigorous, and no curl was ſeen; but on farmers wiſhing to extend the culture of potatoes, they were tempted to plant them on every ſoil, without regard to its nature, or tendency to produce this crop. 2dly, Imperfect culture is deſcribed as a frequent cauſe of curling. A crop of potatoes is commonly ſtrong, abundant, and free from curl, in proportion to the previous culture given to the ſoil, and the care taken to keep it clean after they are planted. Hence, it frequently happens, that while a farmer who cultivates this root in a negligent manner, and upon a great ſcale, by means of the plough, finds his crop deficient in conſequence of this diſeaſe; his cottars and ſervants, to whoſe uſe he allots ſmall portions of potato ground, which they cultivate with the ſpade, obtain crops free from curl, and often double in quantity to his, in proportion to the extent of ground which they occupy. 3dly, Small roots, or too ſmall a portion cut off along with the eye, that is to ſerve for ſeed, appears to be a cauſe of curl. In the caſe of grain, it ſeldom happens, unleſs in very fine ſeaſons, that ſmall ſeed produces a large crop; and it is thought that ſomething ſimilar may occur in the

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caſe of potatoes. As the young plant muſt always derive its earlieſt nouriſhment from the root, out of which it ſprings, before it is capable of ſeeking its food in the ſurrounding ſoil, thoſe plants, whoſe early growth is beſt ſupported and foſtered, muſt be expected to reach the greateſt perfection. To ſubject theſe ideas to the teſt of experiment, 64 ſets were planted; 16 of which were full grown potatoes, 16 from ſmall roots, in which no curl appeared when in the field, 16 from roots raiſed from the ſeeds two years before, and 16 from roots of plants ſtrongly curled. They were all planted in the ſame manner, in a light ſoil, in parallel furrows, with a moderate quantity of dung, and covered to the depth of three inches. Of thoſe taken from large potatoes, none were curled, and the plants were ſtrong and healthy. Some good plants appeared in each of the other rows, but nearly a half of the whole was curled. The proportion of curled plants was rather greateſt in thoſe raiſed from the ſeed. 4thly, Sets taken from roots that have ſprouted early, and from which the germs have been rubbed, are ſaid never to fail to produce curl. 5thly, Too much, as well as too little dung, appears to have an influence in producing curl; the firſt probably by corrupting the germ of the young plant, the latter by not being ſufficient to produce vigorous plants. Hence, attention ought to be paid to the regular ſpreading of dung, which ought not to be thrown about in a careleſs and ſlovenly manner, which allows ſome plants to have none, while others are covered with it to the depth of ſeveral inches. 6thly, Too deep, as well as too ſhallow planting, gives riſe to the curl. To aſcertain the proper depth, 12 were planted at 18 inches deep; the ſame number at the depth of

16 inches, and of 14, 12, 10, 8, 7, 6, 5, 4, 3, and 2 inches; and 12 were ſo lightly covered, that they were not, perhaps at the depth of one inch. The ſets were all from large roots, of the ſame crop, cut as nearly as poſſible of the ſame ſize. They were all planted at the ſame time, in the firſt week of April, in a light dry ſoil, and they all got the ſame quantity of dung. The plants at the depth of 1 and 2 inches appeared firſt; but they were weak, and ſome of them curled. Thoſe at 3, 4, and 5 inches, were all ſtrong, and free from curl. At 6 and 7 inches, they were alſo healthy, and free from curl; but they were three weeks later in getting above the ground than thoſe that were thinly covered, and the plants were neither ſo ſtrong, nor the roots ſo large. Thoſe planted at the depth of 8 inches roſe ſtill later, and were all weak.—Nine out of the 12 were curled. Of thoſe planted at 10 inches deep, only four appeared; and they were ſo weak, that they ſoon withered and died. Of thoſe deeper planted, none ever appeared. On digging them up at the end of two months, thoſe at 16 and 18 inches deep were found unchanged; while ſome of thoſe at the depth of 12 and 14 inches, had put forth ſome feeble germs not exceeding the length of an inch. Thoſe planted at 3 and 4 inches were evidently the ſtrongeſt during the whole ſeaſon, and their roots largeſt. Hence to procure an early, abundant, and healthy crop, 3 inches appears to be the beſt depth for planting potatoes. 7thly, Whatever injures the new ſets or the germs afterwards may produce curl: ſuch as the trampling of horſes feet at the time of planting; their being partially covered with ſtones or hard clods of earth; deep harrowing, when the young ſhoots are advancing; and grubs,

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grubs, ſnails, or inſects attacking the germs at firſt, or the ſtems afterwards. Hence, 8thly, The curl was produced to an uncommon degree upon a field of ſtiff land, by paſſing a roller over it, about a fortnight after planting. 9thly, The ſtate of the weather when the crop is young may produce the curl. Rain alone will not do ſo, if it be not allowed to lodge; but a long continuance of dry weather, eſpecially with cold winds, when the ſhoots firſt appear, is apt to produce this diſeaſe, and alſo hoar-froſts in this early ſtate of the crop. Hence, it is thought, that the three firſt weeks of April anſwer beſt for planting potatoes in the ſouth of Scotland and north of England, as they do not, in that caſe, appear till the middle or end of May. From all theſe remarks it is conculded, that, though with the beſt management, the curl can never be completely baniſhed from our fields, yet with due attention to the leading points above mentioned, it may be prevented from being attended with any ſerious miſchief.

As no information upon this intereſting ſubject ought to be overlooked, we think it neceſſary to ſtate, that the following plan for preventing the curl in potatoes has very recently been laid before the public, by an anonymous correſpondent of the publiſhers of the Farmer's Magazine, who aſſerts, that he has adopted with complete ſucceſs. It conſiſts of uſing for ſeed what are called *potato beans*. Theſe beans are a dark brown excreſcence, larger than a horſe bean, which grows near the ground, on the haulm or ſhaw, generally, it is ſuppoſed, where it has been broken or wounded. They are ſhaped like potatoes, and have a number of eyes, from one of which grow two ſmall leaves. It is ſaid, that eight or ten years ago, ſeveral

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of theſe potato beans were planted merely to try if they would grow, and that they produced a great number of common ſized potatoes, but of a bad quality. Theſe potatoes, however, being cut and planted next year, produced potatoes of an excellent quality, and in great plenty. Since that time, a number of beans have always been planted ſufficient to produce enough of potatoes for next year's ſeed. They are planted at the ſame diſtance, and treated in every reſpect in the ſame manner with common ſets; and their produce is equally plentiful. No other change of ſeed has ever been neceſſary.

SECT. VIII.

OF THE OBSTACLES TO AGRICULTURAL IMPROVEMENT.

Moral and political obſtacles to agricultural improvements.

Before proceeding to the practical part of the ſubject, it may be proper to take notice of ſome of the moral and political circumſtances which reſiſt the progreſs of the art of agriculture, and which ought not to be overlooked by perſons engaged, or who have an intention to engage in it.

Ignorance.

One of the firſt and moſt obvious obſtacles to the improvement of this or of any other art conſiſts of the ignorance of its practitioners, or of its being carried on by perſons of an illiterate and unintelligent character, who are unable to take a comprehenſive view of the principles of their profeſſion, or who have not ſufficient curioſity to inquire after the beſt modes of practice, or underſtanding to diſcern the value of any new prac-

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tices that are explained to them. It ought never to be forgotten, that the art of the huſbandman is an intricate and extenſive one, and that one of the chief circumſtances which has hitherto prevented its improvement has ariſen, as already mentioned, from the ſecluded ſituation of perſons engaged in it. They are ſcattered over the face of the country, inſtead of being collected together like other artiſts in towns, ſo as to be enabled to derive aid from each other's experience. Fortunately this difficulty is paſſing away, in conſequence of the diffuſion of agricultural knowledge, by means of the great number of publications upon that ſubject which are gradually introducing themſelves into the remoteſt corners of the country. Perſons receiving a liberal education, particularly at the univerſity of Edinburgh, have now alſo an eaſier opportunity than formerly of acquiring a knowledge of the principles of this art, in conſequence of the eſtabliſhment of a profeſſorſhip of agriculture, which has been endowed by a private gentleman, Sir William Pulteney. Even with all theſe advantages, however, aided as they are by the exertions of the Board of Agriculture, it can never be expected that this art can reach its ultimate degree of perfection, unleſs a conſiderable number of the perſons engaged in it are men of intelligent characters and good education, who will call in the improvements which are making in other ſciences as well as in this art, in diſtant countries, to the aſſiſtance of their perſonal experience.

In ſpeculation, at leaſt, nobody will deny the utility of general knowledge towards ſucceſs in this profeſſion; as it is evident, that nothing excellent can be accompliſhed by a very ignorant perſon in agriculture

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more than in any other art. It has unfortunately happened, however, in ſome quarters of the country, that the introduction of agricultural improvements has, for ſome time been delayed, in conſequence of the unſucceſsful efforts in this department of buſineſs of ſome men otherwiſe accounted intelligent, who had raſhly engaged in huſbandry. Men of fortune, when they engage in this or in any other undertaking, are apt to diſregard expence when a favourite object is in view, and are unwilling to leave any thing to nature or to time. Hence they introduce coſtly implements of huſbandry, and laborious modes of cultivation, upon a rude, and perhaps upon a poor ſoil, in a cold and unſheltered ſituation. Having laviſhed away much money to little purpoſe, they become diſguſted, and abandon the purſuit of agriculture as unprofitable; and thus their example comes to be regarded by the ignorant as a warning to avoid every kind of novelty; which neceſſarily puts an end to improvement, becauſe all improvements are new.

Such occurrences, however, only eſtabliſh the truth of the maxim, that a little learning is a dangerous thing; a partial knowledge of agriculture leads to haſty ſchemes, ſanguine hopes, and raſh undertakings; whereas a correct acquaintance with the nature of a ſoil, the climate in which it is ſituated, the market which its neighbourhood affords, and the expence of rearing and bringing thither certain crops, leads to moderate and rational views, and to ſlow but ſure ſucceſs. This remark naturally introduces the conſideration of a point of much importance both to individual huſbandmen and to the general improvement of the art; which is, that every perſon engaging in the profeſſion of a huſband-

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man, ought to be well inſtructed in the beſt mode of keeping regular accounts of his affairs, and ought never to neglect, any more than a man engaged in commerce, to keep a correct arithmetical record of all his tranſactions, and of his profits and loſſes. The want of attention to this point has hitherto been one of the greateſt cauſes of the ſlow progreſs of the art of agriculture, and alſo of the want of ſucceſs of many individuals in the practice of it. This ſubject is ſo well diſcuſſed in the Annals of Agriculture *, that, although it is a long quotation, we account ourſelves juſtifiable in inſerting it in this place.

Importance of regular accounts.

"There is not a ſingle ſtep," ſays this judicious writer, "in the life of a farmer that does not prove the advantage of his keeping regular accounts; and yet there is not one in a thouſand that keeps any. This is one, among the many inſtances, in which the unenlightened ſituation of the practiſers of the art is the evident reaſon for the backwardneſs in which the art itſelf is found by any man who ſearches for the principles deduced from practice, which ought to give it the regularity of a cultivated ſcience.

"A few rough memoranda or figures, to yield a groſs account of the general receipt or payment, are uſually the greateſt exertions that common farmers, who pretend to keep accounts, make in this line.

"The advantages of clear accounts are obvious in every other purſuit in life: and to conduct thoſe of a merchant, by the Italian method of double entry, has been an eſſential branch of education for the claſſes intended

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* Vol. xxviii.

tended for commerce. Men engaged in large ſpeculations who are not regular in their accounts, are always ſuppoſed, by the prudent part of the world, to be in a dangerous ſituation; nor is there a greater reproach to a merchant, ſhort of actual bankruptcy.

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"But agriculture is deſtined to be, in all its detail, an exception to every thing elſe. Men engage in it without previous education, or even ſtudy or inquiry; and they conduct large concerns in it without thoſe accounts known to be neceſſary in every other purſuit. With the loweſt and moſt uneducated farmers this is pardonable; but what excuſe have gentlemen for ſuch a conduct?

It ſhould be remembered, that experimental agriculture, or even theſe ideas, more or leſs detailed, which we meet in converſation, muſt depend for their juſtneſs very much on the accuracy of accounts. For a ſuppoſition deduced from general obſervation on a farm, and groſsly conceived, muſt fall exceedingly ſhort for correctneſs of the regular detail of exact accounts.

"The general fact is however admitted, and accordingly it is common to hear gentlemen ſpeak of their accounts. But, unfortunately, they are uſually kept in ſuch a manner as to prove rather the means of fortifying prejudices than removing errors. All thoſe queſtions of nicety where the contraſts are not exceedingly ſtrong, relative to the comparative profit of different ſoils, of different courſes, of different applications of the ſame ſoil, of different modes of culture, &c. depend entirely on accounts. Keep your accounts in the mode of one man, graſs is more profitable than tillage; keep them in a different method, and the contrary ſhall be the reſult. The variety in the mode of

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keeping theſe accounts is very great, and even among gentlemen of conſiderable attention, carefulneſs, and accuracy.

"This comes from the great and undoubted difficulties which riſe in a thouſand forms, whenever an attempt is made at poſitive accuracy. They are not imaginary, but real difficulties, and ſuch as will demand a very conſiderable attention to obviate. I have reflected on the ſubject for many years; and they are few in which I have been ſatisfied with my approach towards accuracy. For while there are diſtinctions that muſt everywhere be kept up, there are many minutiæ that muſt be ſacrificed, in order to render the account tolerably eaſy to keep without an attention that a man in an active line of life cannot give. To keep to this medium is the great difficulty.

"The nature of the farm muſt in ſome inſtances regulate the mode of the accounts. Suppoſe a man has the evil of an open field, or with ſcraps and bits of land ſcattered among his neighbours; in ſuch a caſe it is impoſſible for him to keep an account for every field: and yet this is one of the moſt indiſpenſible points that in general muſt be adhered to; for he who does not know what every field has paid him, is deficient in the very foundation of experience. In this light all little fields on a large farm are nuiſances; they derange accounts entirely if the greateſt attention is not paid, and they are as inconvenient in cultivation, and attended with as much loſs in headlands and borders, as they are ruinous to any exactneſs of account.

"But as many perſons keep accounts without attending to this point, I would obſerve, that when all the wheat, all the barley, all the oats, &c. are reſpectively

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tively thrown together, ſome very eſſential objects of experience depend on gueſſes which ought to be aſcertained correctly. Has fallow, or clover, or beans, paid beſt, as preparations for wheat? How is that queſtion to be anſwered if all are huddled together in one barn or ſtack, and meet in the ſame account? *The farmer can gueſs nearly.* He may: but go to a chemiſt, a phyſician, or a mathematician, and aſk them if their ſciences were puſhed to their preſent perfection by accepting ſuch gueſſes inſtead of experiment? Beſides, they are in their nature quite uncertain; and when a compariſon is formed by two gueſſes, a very little error in each will amount to ſo much in both as to overturn all authority. Another point is, a man's gueſs being influenced by a favourite theory: a rigid friend to fallows, when he draws, by gueſs, a compariſon between them and beans, will be apt, in the nature of things, to be partial: he ſhould not put himſelf in the ſituation. He who would abhor the idea of falſifying a fact that is before him, might gueſs, at leaſt, without ſufficient accuracy.

“If the fields are not very ſmall, the inconvenience of keeping crops ſeparate is little. Stacking corn is by far better underſtood and executed in the iſle of Wight than in any other part of the kingdom: a great ſtack is rarely to be ſeen there; a farmer that has 500 acres of corn, has none but ſmall ones. With ſuch, accounts are kept ſeparate with great facility; at leaſt, if there there are difficulties in it, there are others we ſhall meet with abundantly greater.

“To ſow one field with ſeveral crops at the ſame time, part wheat, part clover, &c. is very bad and inconvenient management, and ought to be avoided, were

accounts

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accounts out of the queſtion. If it cannot be ſhunned they muſt neceſſarily be more complex.

"The firſt object in keeping accounts is to aſcertain the expences in order to divide them properly—Rent, tythe, and pariſh taxes.

"Theſe articles demand three accounts to be kept ſeparate; but they are all to be arranged on the ſame principle. The amount of the two laſt, when known, which is at the end of the year, muſt, like the rent, be divided over every field for which an account is kept: this is very eaſy when the meaſure of the fields is known. I need not obſerve, that the farmer in dividing the rent ſhould do it as exactly and as fairly as poſſible, and that the two other articles ſhould be proportioned to the rent.

"But here occurs one difficulty, which is, I confeſs puzzling. It is the difference between the groſs and the neat meaſure of the fields of an incloſed farm. The hedges, ditches, and borders, take up in many farms a conſiderable portion of the field; from an eighth to a twelfth; and in ſome even more. Now if they are reckoned, and accounted for as part of the field; then the acreable produce is affected, and even the profit of the huſbandry, by a circumſtance not eſſentially connected with it; and if two fields are compared in their huſbandry, that may be moſt advantageous which has leaſt border, and for that reaſon; which would derange a compariſon entirely. I know but one way of getting rid of this difficulty, which is, to meaſure the neat contents where the plough goes in an arable field, and where the ſcythe goes in a graſs one; and then deducting the total of thoſe meaſures from the groſs contents of the farm, throw the difference into one account by itſelf

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itſelf under the title of fences and borders; to which account muſt be charged the proportion of rent, tythe, and pariſh taxes. If wood is cut or grubbed from theſe borders, or graſs is mown from them, the value of the wood or hay to be credited; the expence of the fences to be charged; and the balance of the whole, for it may everywhere be expected to prove a loſing account conſidered as the expence of fences and acreably, divided over the whole farm, like rent, tythe, or pariſh taxes. The only perſon who ever had an attention to this accuracy was Mr Baker, experimenter to the Dublin Society. He publiſhed a map of his farm, with the groſs and neat contents of every field. For want of obſerving this precaution, many experiments have been made, and many concluſions drawn which are mere errors.

"*Sundry expences* may be the title of an account which muſt have place on every farm. Whatever payments concern the farm in general, and not any field or object in particular, and are not included in the preceding articles, muſt be entered under this title. Inſtances are, a bailiff's ſalary, payments to rat or mole-catchers, mending roads upon the farm, expences at market, &c. &c.

"*Wear and tear* includes all payments to blackſmith, carpenter, wheelwright, harneſsmaker, &c. But in the diviſion of this article there muſt be a variation from the preceding: they are divided over the whole farm; but theſe muſt be proportioned differently; the arable lands will abſorb the greateſt part of theſe expences; mowing graſs very little; and feeding graſs ſtill leſs. But to avoid any arbitrary eſtimation when a rule can be eſtabliſhed; the proper mode of dividing this

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this expence per acre will be by making the expence of the teams a rule for it; to find how much per cent. or in the pound of the team-account, this expence of wear and tear amounts to, and charge it accordingly.

“ The team-account is that which is in general more miſtaken than any other on a farm. Nothing is more common than every day to ſee accounts in which ploughing is charged at 4s. an acre, or at 5s. or at 10s. or whatever may be the hiring price of the country; but few words are neceſſary to ſhew that this is entirely fallacious; it is probably much under the real expence. Every practical farmer muſt know that the way to have cheap tillage is to keep the teams well employed: when a man's own work is done, his team ſtands ſtill, if he does not employ it for his neighbours; to do which, he will work for them below the value, and yet find ſome advantage in it. In conſequence of ſuch a conduct being common, to ſay that ſuch is the price of tillage can never be accurate. It has by no means that beſt accuracy of *price*, becauſe you cannot buy your commodity when you want it; and he who depended on the market for all the work of his farm would ſoon find the ſtate of his fields calling for a very different ſyſtem.

“ The means of aſcertaining the real expence of all team-work is very obvious; but depends totally and abſolutely on accurate accounts. So much in ſummer for their green food; ſo much hay and oats eaten; ſo much for ſhoeing and farrier; ſo much for the actual decline of value; and ſo much in labour for attendance, give the real expence of the team. In order to divide this total expence among the work executed, a day-book is neceſſary, which a man may keep himſelf, or truſt to his

bailiff,

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bailiff, as he pleaſes. It muſt contain the work of the teams and men every day in the year, ſpecifying the field or buſineſs they are employed in. At the end of the year the amount of the expence is proportionally divided among the work, and the cleareſt truth and correctneſs are neceſſarily the reſult.

"I ought to obſerve, that this accuracy is very deſireable for aſcertaining various circumſtances. The comparative profit of graſs and arable land depends much on it. Some perſons, from too lightly eſtimating the expence of teams, think arable the moſt profitable; and others, whoſe calculation of thoſe charges runs perhaps too high, give too much into the counter opinion. I can eaſily conceive that many ſtrenuous advocates for fallows might loſe a little of their warmth, if they knew what the expence of ploughing an acre of land really was on their farms. Such inſtances might be multiplied; they are indeed obvious to every man capable of uniting the theory with the practice of a buſineſs.

"The article of manure is much more complex; and, upon the whole, the moſt difficult account there is for a farmer to keep. It muſt be arranged under the title *farm-yard;* and it connects with ſo many objects, that no little care is neceſſary to keep it, and with the greateſt attention ſome doubts will ſtill remain.

"Suppoſe the ſyſtem to be that of carting a ſtratum of marl over the yard before foddering begins; that expence is to be aſcertained at once without any difficulty; but how is the ſtraw to be charged? cattle may be put out to ſtraw in this country at 9d. a-week, and ſome at 6d. At theſe prices a ton will pay about 5s.; but whilſt the cattle may be thus ſupported, the farmer *may buy ſtraw with a view to the dung at 15s. and 18s. and even 20s a ton. This conduct is difficult to ſettle. The price per week is arbitrary [illegible]; we take them at thoſe rates, becauſe they have none or not enough of their own; and it is not aſcertained as the value which cattle will really pay for the ſtraw, which may be more or may be leſs. The whole is uncertain.*

"But with the ſtraw of one's own crop there is a double difficulty, becauſe there muſt be two valuations inſtead of one. We muſt reckon ſo much an acre or load for it, and ſo much a week for the cattle that eat it; but both are ſuppoſitions. Among counter objections one muſt chooſe the leaſt. The beſt method perhaps is to charge the *farm-yard* account with the price of the ſtraw, at which it could be ſold, deducting the expence of carrying it out; and to credit the ſame account with the price per week of keeping the cattle; which price is charged to the debtor ſide of the cattle account, as part of the expences of keeping them. Whatever labour is beſtowed on the dung, in ſhovelling and cleaning yards, throwing up the urine, turning over, &c. is charged of courſe to it. When the whole is carted on the land, the total expence is divided by the number of loads, and the price per load aſcertained. It is charged the year following (as the time conſumed will make that delay neceſſary) to the account of the fields on which it is ſpread; and though the whole advantage is by no means exhauſted by the crop, yet the whole expence muſt be charged to the crop that receives it, or the accounts would be kept open ſo long as to create confuſion.

"The time of balancing the books every year ſhould be that of entering the farm. This is moſt uſual at Michaelmas, but the crop of the year is not then diſpoſed

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of. To avoid valuations which ought never to be relied on when certainty can poſſibly be gained, the old year's accounts are to be kept open long after the new year's ones are begun; that is, till the corn is all threſhed and ſold, till the fatting beaſts are gone, and till all theſe circumſtances are decided which relate to the preceding year. This is eſſential to exact accounts, and can by no means be diſpenſed with. In this caſe, valuations may be totally rejected; but there are others in which no management can exclude them: theſe are, in *live ſtock* not bought and ſold within the year, and *implements*.

"A man may ſtock his farm with cows at 10l. a piece; but if he ſuppoſes them ſome years after to be worth the ſame ſum, he will groſsly deceive himſelf. He muſt value them every year, and alſo the young ſtock which he rears with a view to keep up the number or for ſale; and the rule by which he ſhould make the valuation ought to be the price they would ſell for at the moment. The ſame management muſt direct him with ſucceſſion beaſts, bought or bred for fattening, and alſo with a flock of ſheep. On which laſt head I muſt obſerve, that the want of keeping ſuch accounts as I am deſcribing, is alone the reaſon for a difference of opinion relating to the profit of ſheep. Can any thing be a clearer proof of the barbarity of accounts as they are kept at preſent by ſtock-maſters, than the ſurpriſing queſtion once in agitation among them, whether they gain or loſe by their flocks, a queſtion that has ariſen from Mr Macro's paper on that ſubject publiſhed in this work. Such uncertainty could not obtain if farmers kept regular accounts. The deſcription of the profits of a flock not being properly a calculation, but an

account,

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account, it ought to be tranſcribed from a man's private books. Unfortunately they are kept in ſuch a manner that difficulties multiply at every ſtep in the endeavour to underſtand them.

"Implements muſt all be valued every year; and the balance, being the expence, carried to the wear and tear account which it makes part of.

"One of the moſt complex and difficult accounts, if not the moſt ſo of all, is that of graſs lands fed; it involves itſelf with cattle of all kinds, with hay, with the team, &c. and in ſuch a manner as to make an accurate ſeparation very difficult. How is the value of the feed to be calculated? If 2s. a week for a cow or bullock, or 3d. for a ſheep is charged, it is merely arbitrary. Mr Macro has ſhewed us, by his grazing account, that ſuch eſtimates are to the laſt degree fallacious. They imply profits, but allow nothing for loſſes. On the other hand, if the actual profit or loſs on the live ſtock be made the product; in that caſe, the graſs land muſt be made a mere cattle account. There are obvious objections to this; but it is, upon the whole, much leſs objectionable than a valuation per week, which muſt, in the nature of it, lead to nothing but error. On this principle the account muſt be kept in the following manner.

"One account opened for *mowing ground*, in which the rent, tythe, taxes, and all expences in one total for every field mown, are carried to this account; and the credit of it to conſiſt of the value at the market price, (carriage deducted) of the hay mown as delivered to the team, fatting beaſts, cows, ſheep, &c. which ſeveral accounts are debited with their reſpective conſumptions.

"But the fields which are mown have alſo an after-

graſs,

graſs, which is fed; this muſt of neceſſity be valued at ſo much an acre, and charged to the account of the *feeding ground.* There is no choice in this caſe, for any other mode would create confuſion.

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" That account of *feeding ground* comes next. All the total debits of the fields fed muſt be carried to it. The credit ſide to conſiſt of the food of the teams charged at the price per week, ſuppoſe 2s. and of that of any cattle taken in to joiſt. Theſe articles aſcertain themſelves, but thoſe which reſult from profit on ſtock kept are not ſo eaſily diſcovered.

" There is further a *ſheep* account, a *dairy* one, and another for *fatting beaſts.* In theſe are to be charged all the expences peculiar to thoſe articles,—ſhepherds wages, hurdles, market expences, &c. to the ſheep; dairy fed, fuel, ſtraw yard, &c. to the cows; and the purchaſe money of lean ſtock to fatting beaſts.

" Here, therefore, at the end of the year, lies open before the accountant, five or ſix or more unſettled accounts, not one of which can be cloſed but by reference to each other. Hence ariſes the great complexity of the farmer's accounts; but amidſt this apparent confuſion, order muſt be made to ariſe, or all our labour is vain.

" Further, the fatting beaſts are put to turnips: the cows have turnips, the ſheep have turnips; how is this to be accounted for? This creates a new difficulty, but we muſt examine the beſt mode of clearing it.

" If the cattle-account is charged with the prime coſt of the turnips, that is, with the expence of cultivating them, it will by no means be fair, for the expence is uſually greater than the value; and a man may in a turnip country buy them cheaper than he can cultivate

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vate them: he ſubmits to a known loſs, becauſe he knows he will be more than repaid in the barley that follows them; but to transfer this loſs to the cattle, would be unfair. The plain way of proceeding, therefore, is to value the turnips at what they would ſell for, and to debit the cattle-accounts with their reſpective conſumptions. But there are two prices of turnips: one for carrying the crop on to another man's land; the other, for eating them in the field. The latter ought to be the rate choſen on this occaſion, charging the cattle with the labour and expences of carriage.

"That there is a complexity in this mode of arranging the accounts of live-ſtock is beyond doubt; but after the ſteadieſt and moſt reflected attention that I have been able to give it, I can ſee no mode of ſimplifying it. Submit to the rules here laid down, and you have the ſatisfaction of all the accuracy that is attainable; but in any other method it will remain unknown, whether the profit or the loſs belongs to the land or to the ſtock that feeds upon it.

"I am clear this method will be rejected by thoſe who only read this paper in a common tranſitory manner, without ſtudiouſly examining all the points on which the arrangement depends; but to ſuch as will reflect on what they read, and give the due attention, I have little doubt but this method will appear the only clear and ſatisfactory one.

"When ſo much profit is actually made, to divide it by a weekly account to the fields that fed the ſtock, is making an eaſy calculation with full data before you; but to charge the ſtock with ſo much per week for feeding certain fields when you do not know but the ac-

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count of ſtock may be loſs, not profit, is calculating without any better data than mere ſuppoſition.

"Such are, I apprehend, the principal difficulties in keeping the accounts of a farm. I do not offer the mode as one that obviates all objections. I do not conceive it poſſible to obviate all; but I think that fewer ſources of inaccuracy will be found in it than in any other."

Poverty of huſbandmen.

A ſecond obſtacle to agricultural improvement, conſiſts of the poverty of the huſbandman, or of his want of capital, to enable him fully and completely to labour the ſoil, and provide materials for its amelioration. Complaints have often been made with little reaſon, of the obſtinacy of farmers, and of the tenacious manner in which they adhere to old practices, though demonſtrated to be improper: But a poor man cannot afford to make experiments, or to hazard the loſs of a crop for the chance of obtaining a more valuable one by ſome untried practice. In conſequence of want of capital, large portions of territory remain in ſome parts of the country in a ſtate of nature, and conſequently unproductive, both to the occupier and to the proprietor. Both landlords and tenants, therefore, ought to know, that a man who engages in agriculture without a ſufficient capital takes up a bad trade, in which ſomething may be loſt by both parties by the deterioration both of the ſoil and of the ſtock upon it, but from which neither the public nor themſelves can derive profit.

It is difficult to point out the preciſe extent of capital which a man ought to poſſeſs, to entitle him to engage in agriculture. This muſt neceſſarily vary according to the circumſtances and ſituation of particular diſtricts; and we can only propoſe here to ſtate the general prin-

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ciples which ought to be under the view of a man of ſenſe, while conſidering this important queſtion. We need ſay nothing of the neceſſity which is incumbent not only upon the huſbandman, but upon all perſons engaging in commerce, manufactures, or any other employment, to make proviſion for the firſt outlay of ſtock and expence of labour neceſſary to be encountered before the profits of the buſineſs enable it to ſupport itſelf. We paſs over this original expence, becauſe it has nothing peculiar to agriculture, and becauſe its amount muſt depend upon the extent of the farm occupied, and the manner in which it is to be cultivated. To theſe laſt points only, therefore, we ſhall requeſt attention.

A man about to engage in agriculture ought to poſſeſs ſufficient capital to enable him to occupy a farm of ſuch ſize, as will put it in his power to do juſtice to himſelf, while, at the ſame time, he does full juſtice to the ſoil of which he obtains poſſeſſion: that is to ſay, he ought, in the firſt place, to have ſufficient funds wherewith to ſtock and labour a farm of ſuch magnitude, as will ſufficiently occupy his whole time. If his farm be ſo ſmall as to leave him unemployed for weeks or for months during the year, he can only be ſaid to be a farmer at a time, or occaſionally. At other periods he is either a man without a trade, that is, an idle man, whoſe exiſtence is ſo far uſeleſs to himſelf and to the community; or he muſt engage in other employments, which will withdraw his attention from his principal buſineſs, and ſo far diminiſh the intereſt he takes in its ſucceſs, as to render it far leſs likely to proſper in his hands than it otherwiſe would have been.

A perſon propoſing to engage in agriculture ought not to evade the objection againſt too ſmall a farm, by propoſing to labour himſelf like one of his ſervants. A man of good education, which a farmer ought to be, miſemploys his faculties when he engages in the conſtant drudgery of manual labour; nor will he be qualified to fulfil properly the duties of his ſituation, if he occupy himſelf in this manner. Farming is a liberal art, and conſiſts in appointing and in ſuperintending labour; in keeping a record of its reſult, and in deviſing means for laying it out hereafter to better advantage. Were the farmer to hold his own plough, and perform other menial ſervices, he could not have time to make obſervations, to think, to read, to go to markets, to meet with his neighbours, to ride through the pariſh, and county, and neighbouring counties. Farming is the moſt difficult of all the arts; and, as already mentioned, nothing has retarded its advances ſo much as one farmer not knowing what another is doing at a diſtance from him. It is by no means here inſinuated, that a farmer ought to be ignorant of labour or averſe to it. On the contrary, he ought to be able to hold the plough, to reap, to build and ſtack, and to perform every other agricultural operation. He ought not only to be qualified to perform theſe operations, but he ought actually to engage in them with alacrity upon every preſs of buſineſs, not only for the ſake of having the work done, but to render the labour in which they are employed reſpectable and important in the opinion of his ſervants, and to induce them to proceed in it with cheerfulneſs and vigour, which his example will have no ſmall tendency to accompliſh. The general rule, however, with regard to a farmer's ſituation is this, that he ought to be regarded as the ſuperintending head of a manufactory requiring more vigilant attention than other manufactories;

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tories; becauſe the buſineſs from its nature cannot be conducted in a mechanical train, but requires a change of operations and management according to the variation of ſeaſons and circumſtances. If a man have not ſufficient capital to enable him to occupy a farm which will place him in ſuch a ſtate of continued ſuperintendence, it is evident that he does injuſtice to himſelf, and throws away his time by engaging in ſuch a profeſſion.

At the ſame time it is to be obſerved, that a man acts very improperly, who attempts to occupy a larger farm than his capital will enable him to manage with propriety and ſucceſs. The perfection of agriculture conſiſts, in ordinary caſes, of labouring the ſoil by the moſt perfect and frequent tillage, and of enriching it by large quantities of manure. With regard to the former of theſe, it evidently cannot be accompliſhed, without obtaining, at whatever price they may coſt, the beſt horſes, the moſt ſkilful farm ſervants, and the beſt ploughs or other inſtruments of huſbandry. An extraordinary outlay of money is alſo ſometimes neceſſary. It frequently happens that a ſoil is in a ſtate unfit to produce valuable crops, which might nevertheleſs, by an expence which it would amply repay, be ſpeedily rendered extremely fertile; as in the caſe of lands that require to be drained, or of lands ſo ſituated as to admit of a ſtream of water being periodically poured over their ſurface. It is evident, that a man commits a crime againſt ſociety who attempts to farm ſuch lands, without poſſeſſing ſufficient capital to enable him to do them juſtice by introducing theſe improvements.

With regard to the importance of repairing the exhauſted

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hauſted powers of the ſoil by abundance of manure, and of the neceſſity of a farmer poſſeſſing ſufficient capital to enable him to do ſo, too much cannot poſſibly be ſaid. Nature is extremely grateful for every care beſtowed upon the ſoil in this reſpect: not only does ſhe repay with manifold intereſt on ordinary occaſions every expence of manure, however profuſely laid out, but ſhe even places the agriculturiſt who acts liberally in this way, in ſome meaſure beyond the reach of fortune. In calamitous ſeaſons, when nations ſuffer in conſequence of ſterility, the farmer whoſe lands are in excellent condition, by being richly manured, ſeldom fails to reap two-thirds of his uſual crop, for which he receives perhaps three times the ordinary price; while other huſbandmen, poſſeſſing leſs ſkilful induſtry or leſs capital, have to regret the total unproductiveneſs of their fields.

The expence of providing manure may be different in different ſituations. In the neighbourhood of great cities it may amount to nothing more than the ſum that is paid for it; but at a diſtance from theſe it becomes neceſſary for the farmer to be at the expence of purchaſing, perhaps at a very high rate, a large ſtock of cattle, and to rear ſuitable crops of turnips, &c. for their food, that he may be enabled to enrich his lands by their dung. It may indeed be juſtly ſaid, that in proportion to the quantity of cattle thus kept on a certain extent of ſoil for the purpoſe of renovating its fertility, and enabling it to produce heavy crops of grain, may the perfection to which the agriculture of any country has attained be fairly eſtimated.

In ſhort, it is only by men poſſeſſing a conſiderable capital, that agriculture can be improved or carried on

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in ſuch a manner, as to bring any portion of ſoil to its utmoſt degree of fertility. What Arthur Young, Eſq.* has ſaid of ſmall farms and ſmall farmers applies, in truth, to farmers deſtitute of ſufficient capital. "Let me demand of the advocates for ſmall farms," ſays this writer, "where the little farmer is to be found who will cover his whole farm with marl, at the rate of 100 or 150 tons per acre; who will drain all his lands at the expence of two or three pounds an acre; who will pay a heavy price for the manure of towns, and convey it 30 miles by land carriage; who will float his meadows at the expence of 5l. per acre; who, to improve the breed of his ſheep, will give 1000 guineas for the uſe of a ſingle *ram* for a ſingle ſeaſon; who will give 25 guineas per cow for being covered by a fine bull; who will ſend acroſs the kingdom to diſtant provinces for new implements, and for men to uſe them; who employ and pay men for reſiding in provinces, where practices are found which they want to introduce on their farms? At the very mention of ſuch exertions, common in England, what mind can be ſo perverſely framed as to imagine, for a ſingle moment, that ſuch things are to be effected by little farmers? Deduct from agriculture all the practices that have made it flouriſhing in this iſland, and you have preciſely the management of ſmall farms."

We may farther mention, that a farmer ought to poſſeſs ſufficient capital, or ſufficient credit, to enable him to retain in his poſſeſſion his crop during ſix or eight months after it is reaped. It is neceſſary, both for his own intereſt, and for the intereſt of the public, that he ſhould have it in his power to do ſo. He himſelf cannot poſſibly expect to receive the beſt prices, nor conſequently to obtain the juſt profit which ought to reſult from his profeſſion, if he is under the neceſſity of inſtantly bringing to ſale the produce of his farm, without being able to wait for the beſt ſtate of the market. In a country in which commercial ſpeculations are prevalent, it is extremely neceſſary, that farmers ſhould be able to keep back their grain for a time from the market, for the ſake of protecting the public againſt the combinations of monopolizing ſpeculators. Farmers themſelves are always too numerous a body to be able to injure the public by improper combinations to raiſe the price of grain; but if they were in general needy men, under the neceſſity of bringing their produce to market at the concluſion of the harveſt, there would exiſt no means of preventing combinations of monied men from obtaining at all times a complete command over the price of proviſions; and producing an artificial ſcarcity by buying up the grain.

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* *Travels into France*, vol. i.

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A third obſtacle to agricultural improvement ſometimes ariſes from the poſſeſſor of the ſoil not having a ſufficient intereſt in it. In barbarous nations, lands are often poſſeſſed by communities as an undivided property, without any individual member having an excluſive right to a particular ſpot. In ſuch caſes, the worſt kind of agriculture muſt always prevail; for the ſame reaſon that public affairs are always worſe managed than the affairs of private perſons, who find their induſtry ſtimulated not merely by a ſenſe of duty, but by the influence of avarice, and of all the other ſelfiſh paſſions. Conſiderable portions of territory in England

Want of intereſt in the ſoil.

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in all probability with bad temper on the part both of the landlord and tenant; the one endeavouring to enforce, and the other to evade, the ſtipulations of the contract. The temptation is indeed, ſo great, to exhauſt a ſoil during the laſt years of a leaſe, that it becomes neceſſary to the intereſt of the public and of the landlord, that the mode of cropping ſhould be regulated during theſe laſt years. Beyond this point, however, a man of ſpirit engaging in agriculture, ought not to ſuffer himſelf to be fettered, but ought to ſecure for himſelf an opportunity of making uſe of whatever additional improvements his art may receive, either from the enterpriſes of others, or from his own increaſing ſkill and experience.

Under the ſame head of a want of proper intereſt in the ſoil, may be enumerated the payment of tithes, of which in England every farmer ſo grievouſly complains. Whatever money the huſbandman may there lay out in improvements, is not expended for himſelf; as the proprietor of the tithes is entitled to draw a ſhare of the whole additional increaſe, and thus becomes a partner in the profits of the enterpriſe, without running any riſk of loſs by its failure. The odium of this tax, is ſaid to induce great numbers of huſbandmen to continue their lands in paſturage, to the no ſmall detriment of the public, from the comparative unproductiveneſs of human food, which attends that mode of occupying the ſoil. Fortunately in Scotland this evil has been removed, by the wiſdom of our forefathers, as every landlord poſſeſſes the privilege of obtaining his tithes to be fixed at a ſettled rate of payment for ever; and, in many caſes, of having his lands altogether diſburdened, upon payment of a very moderate price.

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Want of reſpectability of the profeſſion.

The progreſs of the art of agriculture in Europe was long retarded by the want of reſpectability which attended it, when engaged in as a profeſſion or trade from which profit was to be derived. In the feudal times, the military profeſſion was the only employment in which a layman of liberal education could reſpectably engage. Agriculture, the only art which is abſolutely neceſſary to the exiſtence of man, was regarded with contempt, and left in the hands of the meaneſt of the people. Even the moſt ordinary mechanics were conſidered as ſuperior to perſons whoſe employment it was; becauſe the mechanic, reſiding in a town, and uſually under the protection of the prince, was ſafe from the dominion and the inſults of the petty chieftains that ruled in every part of the open country. The ſtate of affairs is now greatly altered in this reſpect: More enlightened views, and a better ſtate of ſociety, have reſtored to the profeſſion of agriculture the reſpectability which naturally belongs to it. It muſt be acknowledged, however, that the recent improvements which have taken place in the art, have contributed not a little to this change in the ſentiments of mankind concerning the perſons occupied in it. It is now found, that a man may become rich by agriculture, and that there are few better ways in which a prudent and induſtrious man can lay out a moderate capital. In a commercial age, the path that leads to wealth is always reſpected and accounted honourable, and accordingly it is now not unuſual for the ſons of Britiſh noblemen, and gentlemen of extenſive fortunes, to become apprentices to farmers.

Obſtacles to Agriculture.

Defective legiſlation.

The laſt obſtacle to agricultural improvements, of which we ſhall take notice, ariſes in ſome countries from the want of judicious legiſlation, or proper arrangements made by the public in its favour. The produce of the art of the huſbandman, and the manures for which his lands have occaſion, are all bulky commodities, which cannot be tranſported without labour and expence. Unleſs care is taken, therefore, to prepare and maintain good roads throughout the country, the profits of agriculture muſt always be ſubjected to ſuch deductions as will greatly retard its proſperity. In the ſame manner, if the ſtate, from any narrow policy, ſhall prevent the huſbandman from bringing his goods to the beſt market, by exportation or otherwiſe, it is impoſſible that his art can flouriſh. In former times, nations were afraid to permit the exportation of grain, even in ſeaſons of plenty, leſt they ſhould be left without food, not conſidering that the ſureſt mode of producing abundance of any commodity conſiſts in offering, at all times, a good price for it. This error is now rectified in moſt nations; and at all events, in the preſent ſtate of affairs, the Britiſh huſbandman has no reaſon to complain, as the grain reared in this country is, even in the beſt ſeaſons, underſtood to be inadequate to afford ſubſiſtence to its inhabitants.

PRACTICE OF AGRICULTURE.

Diviſion of the ſubject.

THE practice of agriculture naturally divides itſelf into three parts: 1ſt, The cultivation of vegetable food for men and animals; 2dly, The cultivation of vegetables, ſuch as flax and hemp, which are more properly articles of commerce; and 3dly, The rearing and management of animals. To theſe we ſhall add, as connected with all the branches of agriculture, a ſhort deſcription of the moſt uſual modes of fencing and encloſing lands for cattle and other objects of huſbandry.

PART I.

OF THE CULTIVATION OF VEGETABLE FOOD.

Cultivation of vegetables divided into four branches.

WE ſhall conſider this branch of the ſubject under four diviſions. In the firſt we ſhall preſent to the reader a ſtatement of the moſt uſeful inſtruments of agriculture. 2dly, We ſhall ſtate the mode of preparing land for cropping, by removing the phyſical obſtructions to agriculture, and reducing the ſoil into a proper ſtate. 3dly, We ſhall explain the culture of particular plants, and the practices of huſbandry connected with it; and, laſtly, We ſhall ſtate the principles and operations of the horſehoeing or drill huſbandry.

SECT. I.

INSTRUMENTS OF HUSBANDRY.

THE inſtruments employed in agriculture are various; as the plough, the harrow, the roller, &c, which are again diverſified by various conſtructions adapted to particular uſes.

1. *Of Ploughs.*

The plough

The plough is a machine for turning up the ſoil by the action of cattle, contrived to ſave the time, labour, and expence, which, without this inſtrument, muſt have been employed in digging the ground, and fitting it for receiving all ſorts of ſeeds.

Inſtruments of Huſbandry.

Amidſt all the varieties which can occur in the manner of ploughing the ground, ariſing from difference of ſoil, local habits, and other cauſes, there is ſtill a ſameneſs in the taſk which gives a certain uniformity to the chief parts of the inſtrument, and ſhould therefore furniſh principles for its conſtruction. There is not, perhaps, any invention of man that more highly merits our utmoſt endeavours to bring it to perfection; but it has been too much neglected by thoſe perſons who ſtudy mechanics, and has been conſidered as a rude tool, unworthy of their attention. Any thing appears to them ſufficient for the clumſy taſk of turning up the ground; and they cannot imagine that there can be any nicety in a buſineſs which is ſucceſsfully performed by the ignorant peaſant. Others acknowledge the value of the machine, and the difficulty of the ſubject; but they think that difficulty inſuperable, becauſe the operation is ſo complicated, and the reſiſtances to be overcome ſo uncertain, or ſo little underſtood, that we cannot diſcover any unequivocal principle, and muſt look for improvement only from experience or chance.

an inſtrument of the greateſt value,

But theſe opinions are ill founded. The difficulty is indeed great, and it is neither from the ignorant farmer nor the rude artiſt that we can expect improvement. It requires the ſerious conſideration of the moſt accompliſhed mechanician; but from him we *may* expect improvement. We have many data: we know pretty diſtinctly what preparation will fit the ground for being the proper receptacle for the ſeed, and for ſupporting and nouriſhing the plants; and though it is, perhaps, impoſſible

and may be improved.

impoſſible to bring it into this ſtate by the operation of any inſtrument of the plough kind, we know that ſome ploughs prodigiouſly excel others in reducing the ſtiff ground to that uniform crumbling ſtate in which it can be left by the ſpade. The imperfections of their performance, or what yet remains to be done to bring the ground to this ſtate, is diſtinctly underſtood. It ſeems, then, a determinate problem (to uſe the language of mathematicians), becauſe the operation depends on the invariable laws of mechanical nature.

The taſk it performs.

It will therefore be very proper under this article, to aſcertain, if poſſible, what a plough in general ought to be, by deſcribing diſtinctly its taſk, This will ſurely point out a general form, the chief features of which muſt be found under every variety that can ariſe from particular circumſtances.

The plough performs its taſk, not by digging, but by being pulled along. We do not aim at immediately reducing the ground to that friable and uniform ſtate into which we can bring it by the ſpade; but we wiſh to bring it into ſuch a ſtate that the ordinary operations of the ſeaſon will complete the taſk.

For this purpoſe, a ſlice or ſod muſt be cut off from the firm land. This muſt be ſhoved to one ſide, that the plough and the ploughman may proceed in their labour; and the ſod muſt be turned over, ſo that the graſs and ſtubble may be buried and rot, and that freſh ſoil may be brought to the ſurface; and all muſt be left in ſuch a looſe and open condition, that it may quickly crumble down by the influence of the weather, without baking into lumps, or retaining water. The firſt office is performed by the coulter, which makes a perpendicular cut in the ground. The point of the ſock follows this, and its edge gets under the ſod, and lifts it up. While lifting it up, it alſo heels it over, away from the firm land. The mouldboard comes laſt, and puſhes it aſide, and gradually turns it over as far as is required.

Inſtruments of Huſbandry.

Plate XI. General form of the plough.

The general form of the body of a plough is that of a wedge, or very blunt chiſſel, AFEDBC, (fig. 1.), having the lower corner D of its edge conſiderably more advanced than the upper corner B; the edge BD and the whole back AFDB is the ſame perpendicular plane; the bottom FDB approaches to a triangular form, acute at D, and ſquare at F; the ſurface BCED is of a complicated ſhape, generally hollow, becauſe the angle ABC is always greater than FDE: this conſequence will be eaſily ſeen by the mathematician. The back is uſually called the LAND SIDE by the ploughman, and the baſe FDE is called the SOLE, and FE the HEEL, and BCED the MOULDBOARD. Laſtly, The angle AFE is generally ſquare, or a right angle, ſo that the ſole has level both as to length and breadth.

Advantages of this form.

By comparing this form with attention, the reader will perceive that if this wedge is pulled or puſhed along in the direction FD, keeping the edge BD always in the perpendicular cut which has been previouſly made by the coulter, the point D will both raiſe the earth and ſhove it to one ſide and twiſt it over; and, when the point has advanced from F to D, the ſod, which formerly reſted on the triangle DFE, will be forced up along the ſurface BCED, the line DF riſing into the poſition D*f*, and the line EF into the poſition E*f*.—Had the bottom of this furrow been covered with a bit of cloth, this cloth would be lying on the mouldboard, in the poſition D*f*E: the ſlice, thus deranged from its former

ſituation,

ſituation, will have a ſhape ſomething like that repreſented in fig. 2.

In as much as the wedge raiſes the earth, the earth preſſes down the wedge; and as the wedge puſhes the earth to the right hand, the earth preſſes the wedge to the left; and in this manner the plough is ſtrongly preſſed, both to the bottom of the furrow by its ſole, and alſo to the firm land by its back or land ſide. In ſhort, it is ſtrongly ſqueezed into the angle formed along the line FD (fig. 1.) by the perpendicular plane *a b* DF and the horizontal plane FDE; and in this manner the furrow becomes a firm groove, directing the motion of the plough, and giving it a reſiſting ſupport, by which it can perform all parts of its taſk. We beg our readers to keep this circumſtance conſtantly in mind. It evidently ſuggeſts a fundamental maxim in the conſtruction, namely, to make the land ſide of the plough an exact plane, and to make the ſole, if not plane, at leaſt ſtraight from point to heel. Any projection would tear up the ſupporting planes, deſtroy the directing groove, and expend force in doing miſchief.

A fundamental maxim in the conſtruction of a plough.

This wedge is ſeldom made of one piece. To give it the neceſſary width for removing the earth would require a huge block of timber. It is therefore uſually framed of ſeveral pieces, which we ſhall only mention in order to have the language of the art. Fig. 3. repreſents the land ſide of a plough, ſuch as thoſe made by James Small at Roſebank, near Foord, Mid Lothian. The baſe of it, CM, is a piece of hard wood, pointed before at C to receive a hollow ſhoeing of iron CO, called the SOCK, and tapering a little towards the hinder end, M, called the HEEL. This piece is called the HEAD of the plough. Into its fore part, juſt behind the ſock,

The ſeveral parts of the plough.

ſock, is mortiſed a ſloping poſt, AL, called the SHEATH, the front of which is worked ſharp, forming the edge of the wedge. Nearer the heel there is mortiſed another piece, KQ, ſloping far back, called the STILT, ſerving for a handle to the ploughman. The upper end of the ſheath is mortiſed into the long BEAM RH, which projects forward, almoſt horizontally, and is mortiſed behind into the ſtilt. To the fore end of the beam are the cattle attached. The whole of this ſide of the wedge is faſhioned into one plain ſurface, and the intervals between the pieces are filled up with boards, and commonly covered with iron plates. The COULTER, WFE, is firmly fixed by its ſhank, W, into the beam, rakes forward at an angle of 45° with the horizon, and has its point E about ſix inches before the point of the ſock. It is brought into the ſame vertical plane with the land ſide of the plough, by giving it a knee outward immediately below the beam, and then kneeing it again downward. It is further ſupported on this ſide by an iron ſtay FH, which turns on a pin at F, paſſes through an eye-bolt I on the ſide of the beam, and has a nut ſcrewed on it immediately above. When ſcrewed to its proper ſlope, it is firmly wedged behind and before the ſhank. Fig. 4. repreſents the ſame plough viewed from above. ST is the right hand or ſmall ſtilt fixed to the inſide of the mouldboard LV.

Fig. 5. repreſents the bottom of the wedge. CM is the head, covered at the point by the ſock. Juſt behind the ſock there is mortiſed into the ſide of the head a ſmaller piece DE, called the wreſt, making an angle of 16° with the land ſide of the head, and its outſide edge is in the ſame ſtraight line with the ſide of the ſock. From the point to the heel of the head is about

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33 inches, and the extreme breadth of the heel is about nine. The ſide of the wedge, called the furrow ſide, is formed by the mouldboard, which is either made of a block or plank of wood, or of a thick iron plate.

Socks.

The ſock drawn in this figure is called a SPEAR SOCK, and is chiefly uſed in coarſe or ſtony ground, which requires great force to break it up. Another form of the ſock is repreſented in fig. 6. of the ſame plate. This is called a FEATHER SOCK, and has a cutting edge CF on its furrow ſide, extending back about ten inches, and to the right hand or furrow ſide about ſix. The uſe of this is to cut the ſod below, and detach it from the ground, as the coulter detaches it from the unploughed land. This is of great uſe when the ground is bound together by knotted roots, but it is evident that it cannot be uſed to advantage in very ſtony ground. In general, the feather ſock is only fit for ground which has been under tolerable culture; but it greatly facilitates the labour of ſeparating the ſod. It may reaſonably be aſked, why the feather is not much broader, ſo as to cut the whole breadth of the furrow? This is ſometimes done. But we muſt recollect that the ſod is not only to be puſhed aſide, but alſo to be turned over. If it were completely detached by the feather, and chanced at any time to break on the back of the ſock, it would only be puſhed aſide; but by leaving a little of the ſod uncut, it is held faſt below while it is ſhoved aſide above, which cannot fail to twiſt it round. As the wreſt advances, it eaſily deſtroys the remaining connexion, which in general is very ſlight and crumbling.

Proper breadth of the ſole.

The breadth of the ſole at the heel determines the width of the furrow. Nine inches will give enough of room for a horſe or man to walk in. A greater breadth is of no uſe, and it expends force in puſhing the earth aſide. It is a miſtake to ſuppoſe that a broad ſole gives more room for the turned ſlice to ſtand on; for whatever is the breadth of the furrow, the ſucceſſive ſlices will be left at their former diſtances, becauſe each is ſhoved aſide at the ſame diſtance. When the breadth of a ſlice exceeds its depth, and it is turned on its ſide, it will now ſtand on a narrow baſe, but higher than before, and therefore will ſtand looſer, which the farmers deſire. But in this caſe it generally falls on its back before it has been far enough removed, and is then puſhed aſide, and left with the graſſy ſide down, which is not approved of. On the other hand, when the depth conſiderably exceeds the breadth, the ſods, now turned on their ſides, muſt be ſqueezed home to the ploughed land, which breaks them and toſſes them up, making rough work. In wet clay ſoil, this is alſo apt to knead them together. On the whole, it is beſt to have the breadth and depth nearly equal. But all this is workmanſhip, and has no dependence on the width of the ſole behind.

It ſhould be level.

We have already ſaid that the ſole is generally level from right to left at the heel. This was not the caſe formerly, but the wreſt was conſiderably raiſed behind. It reſulted from this form, that the furrow was always ſhallower on the right ſide, or there was left a low ridge of unſtirred earth between the furrows. This circumſtance alone was a bad practice; for one great aim of ploughing is the renewal of the ſuperficial ſoil. In this way of ribbing the furrows, the ſod tumbles over as ſoon as it is puſhed to the top of the rib on the right of the *rut* made by the plough; the firmeſt parts of it fall undermoſt, and the reſt crumbles above it, making the work appear neat; whereas it is extremely unequal, and what moſt needs the influence of the weather to crumble it down is ſheltered from it. Add to theſe circumſtances, that the hollow is a receptacle for water, with a ſurface which can retain it, having been conſolidated by the preſſure of the plough. For all theſe reaſons, therefore, it ſeems adviſable to form the furrow with a flat or level bottom, and therefore to keep the heel of the wreſt as low as the heel of the head. For the ſame reaſon it is proper to hold the plough with the land ſide perpendicular, and not to heel it over to that ſide, as is frequently done, producing the ſame ribbed furrow as an ill formed ſole.

Length of the plough.

There is great variety of opinions about the length of the plough. If conſidered merely as a pointed inſtrument, or even as a cutting inſtrument acting obliquely on a given length of ſod, there can be no doubt but that it will be more powerful as it is longer: that is, it will require leſs force to pull it through the ground. But it muſt alſo ſhove the earth aſide, and if we double its length we cauſe it to act on twice as much earth at once; for when the plough has entered as far as the heel, the whole furrow ſide is acting together in puſhing the earth to the ſide. Now it is found, that the force neceſſary for puſhing a maſs of earth horizontally along the rough ground is nearly equal to its weight. It would ſeem, therefore, that nothing is to be gained by making the baſe of the plough of a great length, except a greater facility in making the firſt penetration, and this is chiefly performed by the coulter and ſock; and a great length renders the plough heavy and cumberſome, and, by cauſing it to act long on the ſod, tends to knead and cake it.

Nothing very preciſe can be offered on this ſubject. Some

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Some ſenſible advantage is derived by making the plough taper, eſpecially forward, where it acts as a boring and cutting inſtrument; and for this purpoſe it is convenient to give the coulter a ſlope of 45 degrees. (This has alſo the advantage of throwing up the ſtones and roots, which it would otherwiſe drive before it through the firm ground.) And for the ſame reaſon the edge of the feather has a great ſlope, it being 10 inches long and only ſix inches broad. But if we purſue this advantage too far, we expoſe ourſelves to another riſk. It is ſometimes neceſſary to heel over the plough to the right in order to get over ſome obſtruction. In doing this, the coulter is neceſſarily raiſed for a moment, and the ſlanting cut now made by the feather becomes the directing groove for the plough. When the feather has a very long ſlope, this groove has force enough to guide the whole plough; and it is almoſt impoſſible for the ploughman to prevent it from running out of the ground to the land ſide *. The feather, therefore, ſhould not exceed ten or twelve inches in length.

Slope of the coulter and of the feather.

But to return to the length of the plough, from which this obſervation has diverted us a little, we muſt add, that a long plough has a great advantage in the ſteadineſs of its motion, having a much more extenſive ſupport both on the land ſide and below, and being therefore leſs affected by its inequalities. Accordingly they are now made conſiderably longer than formerly; and

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* This is often felt with the excellent plough deſcribed by Mr Arbuthnot of Surry, in the Tranſactions of the Society for the Encouragement of Arts, &c. London.

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33 inches has been aſſumed as a proportion to 9 inches of breadth, in conformity to the moſt approved ploughs now in uſe.

The mouldboard.

We come now to treat of the mouldboard. This is the moſt delicate part of the plough, and is to be ſeen in the greateſt variety in the works of different artiſts, each of whom has a noſtrum of great value in his own opinion. It is here indeed that the chief reſiſtances are exerted and muſt be overcome; and a judicious form of this part of the plough may diminiſh them conſiderably, while it performs the work in the beſt manner. Without pretending to ſay that the different reſiſtances are ſuſceptible of an accurate determination, we can ſtill draw ſufficient information from palpable rules of mechanics to direct us to what would be nearly the beſt poſſible form for a mouldboard. The taſk to be performed is to raiſe, puſh aſide, and turn over to a certain degree, a ſlice already cut off from the firm ground. As we cannot provide for every inequality of the coheſion or tenacity of the earth, our ſafeſt way is to conſider it as uniform: the weight of it is always ſo. As we cannot provide for every proportion between the tenacity and the weight, we muſt take an average or medium proportion which is not far from that of equality. Conceiving the ſlice at firſt as only tenacious, and without weight, it is an eaſy problem to determine the form which ſhall give it the intended twiſt and removal with the ſmalleſt force. In like manner we can proceed with a ſlice that has weight without tenacity. It is equally eaſy to combine both in any proportion; and it is eaſieſt of all to make this combination on the ſuppoſition of equality of weight and coheſion. Suppoſing the ſlice like a brick, we know that it requires the greateſt force to begin to raiſe it on one edge, and that the ſtrain becomes leſs as it riſes, till its centre of gravity is perpendicularly above the ſupporting angle. It requires no force to raiſe it further; for on puſhing it beyond this poſition, it would fall over of itſelf, unleſs withheld by the tenacity of what is not yet raiſed. But on conſidering the form or plan of the ſock, we find that while the weight of the ſod reſiſts moſt ſtrongly, there is leſs of it in this ſituation actually riſing, and this nearly in the ſame proportion with the labour of raiſing it; and we ſee that after the ſod has attained that poſition in which it is ready to fall over, it has reached the wider part of the wreſt, and is now puſhed aſide, which requires nearly the ſame force as to raiſe it: and this continues to the end of the operation.

When we take all theſe circumſtances into conſideration, it appears probable, that the compound reſiſtance does not change much from firſt to laſt. If this be really the caſe, it is an undoubted maxim that the whole operation ſhould proceed equably: if it does not, there muſt be ſome part of the ſod that makes a reſiſtance greater than the medium; and as the reſiſtances in all this claſs of motions increaſe nearly as the ſquares of the velocities with which they are overcome, it is demonſtrable that we ſhall loſe power if we render them unequal.

How to be formed.

Hence we deduce this maxim, *That as the plough advances through equal ſpaces, the twiſt and the lateral ſliding of the ſod ſhould increaſe by equal degrees.* And this determines *a priori* the form of the mouldboard. This principle occurred to Mr James Small, a ploughmaker in Berwickſhire, and he publiſhed a treatiſe on the ſubject in 1784. He has given ſeveral methods for conſtructing mouldboards, which he ſuppoſes are in conformity to his principle; but being merely a country artiſt, and unacquainted with ſcience, his rules do not produce mouldboards having this property of equable operation, although they do not deviate far from it. His book is a very uſeful and inſtructive performance, and level to the capacity of thoſe for whom it is intended; and we have here availed ourſelves of the author's information on many points.

The high character which Small's ploughs have maintained for 28 years is a ſtrong argument for the truth of the maxim. We ſhall, therefore, give ſuch inſtructions as will enable any intelligent workman to conſtruct ſuch a mouldboard without any riſk of failure; and if future theory or experience ſhould diſcover any error in the principles from which this maxim is deduced, by ſhowing that either the weight, the tenacity, or the lateral reſiſtance, is exerted according to a different law from what has been aſſumed, the directions to be given are of ſuch a nature that they adapt themſelves with preciſion to theſe changes of principle, and will ſtill produce a perfect and efficacious plough. Our readers will readily acknowledge that this is gaining a great point; becauſe at preſent the inſtrument is conſtructed very much at random, and by a gueſs of the eye.

Plate XI. Let us now return to the wedge formerly made uſe of for illuſtrating the action of the plough. Suppoſe it placed in a furrow already ploughed, and that the ſpace before the line FE (fig. 1.), which is ſquare from the line of motion FD, is covered with a piece of cloth or carpet, and that the point of the wedge enters upon it at F, and advances to D. It will evidently raiſe the

cloth,

Plate XI.

cloth, which will now cover the ſide of the wedge, forming the triangle *f* DE. The line *f* D is what formerly lay in the angle along the line FD, and *f* E formerly lay on FE. It is this line FE, therefore, that we are to raiſe, ſhove aſide, and twiſt round, by equal degrees, while the plough advances through equal ſpaces.

Now, if the length DF of the plough-wedge, reckoned from the point of the ſock to the heel, be 33 inches, and the breadth FE behind be 9 inches, the angle DEF or DE *f* will be nearly 74°. The conſtruction of the furrow ſide of the plough is therefore reduced to this very ſimple problem, "To make the angle DE *f* turn equably round the axis DE, while the angular point L advances equably from D to E.

Deſcription of an inſtrument for this purpoſe.

This will be done by means of the following very ſimple tool or inſtrument. Let IHFK (fig. 7.) be a piece of hard wood, ſuch as oak, a foot long, three inches broad, and an inch thick. Plant on this another piece BHFC of the ſame breadth, four inches long, and half an inch thick. This will leave beyond it a flat 8 inches long. We ſhall call this the *ſtock* of the inſtrument. Let ABC be a piece of clean oak half an inch thick, 20 inches long, and 3 inches broad at the end BC. Let this be faſhioned like the ſtyle of a ſundial, having its angle ABC 74°. Let it have a part BCE ſquare, to the extent of 4 inches from C, and the reſt EA worked into the form of a ſtraight ſlender rod. Let EFG be a ſemicircle of clean plane tree, or of metal, 4 inches radius: faſten this by ſmall ſcrews to the ſquare part of the ſtyle CE, ſo that its centre may be at C. Let this ſemicircle be divided into 180 degrees, and numbered from G along the arch GFE, ſo that 0° may be at G, and 180° at E. Let this ſtyle and ſemicircle turn round the line BC by means of ſmall hinges. This inſtrument may be called the mouldboard gage, or protractor. When the ſtile is folded down on the ſtock BIK, the point G will be at F; and, when it is raiſed up to any angle, the degrees will be pointed out on the ſemicircle by the ſtraight edge CF.

Nothing can be more obvious than the manner of employing this inſtrument, once we have determined the moſt proper poſition for the ſod when the work is completed. Now it ſeems to be the opinion of the moſt intelligent farmers, that the beſt poſition of the ſod is that repreſented in fig. 1. Plate XII.

Proper poſition of the ſod. Plate XII.

Fig. 1. repreſents a ſection of the ground and the working parts of the plough, as viewed by a perſon ſtanding ſtraight before it. ABDC is the unploughed ground, and WB the coulter, kneed in Small's manner. FGKB is the ſection of the plough (or rather of the whole ſpace through which the plough has paſſed, for no part of the plough has this ſection). HOFE is the ſection of a ſlice, puſhed aſide and turned over, ſo as to lean on the next. HE is that ſide of the ſlice which formerly lay on KB. EF is the ſide cut off by the coulter; and FO is the upper or graſſy ſide. The lower corners are ſuppoſed to be a little bruiſed inwards, as muſt generally happen.

The ſod is puſhed 9 inches to the right hand, and it leans with its graſſy ſide on the preceding furrow, in an angle of about 50 degrees. In this poſition the graſs is turned down ſo as to rot; and there is a hollow left below to allow the rain water to run freely off, and to receive the earth as it crumbles down by the

Inſtruments of Huſbandry. Plate XII.

the weather: and if the harrow is dragged acroſs theſe ridges, it diſtributes along the ſurface the mould which was formerly at the bottom. The ſod has got a twiſt of 130 degrees: but it is evident, that after it has been turned 90 degrees, or even a little before this, it is ready to fall over of itſelf. It is ſufficient, therefore, that it be turned 90 degrees when the heel of the wreſt has reached it, and the remainder of the twiſt is given to it by the wing or flap of the mouldboard. This, then, dictates to us the manner of applying the inſtrument.

How to form the mould-board.

Divide the edge DE (fig. 2.) of the wreſt, or of a lath nailed on it, into 90 equal parts, and continue the diviſions backwards to G in the ſame line to 130. Number the diviſions backwards from the point of the ſock; then place the protractor on the edge of the wreſt with the point B of fig. 7. Plate XI. at the 90th diviſion (fig. 2. Plate XII.); that is, juſt at the heel, with the ſtock under the wreſt, and the ſtile raiſed to 90°, and preſs it home to the joint, ſo that the ſtock may be ſquare to the edge, and then the ſtyle will be in the poſition ſuiting that part of the mouldboard. In like manner ſlide the ſtock forwards to the 80th diviſion, and lower the ſtyle to 80°, and it will have the poſition which ſuits that part of the mouldboard. In the ſame way ſlide it forward to 70, 60, 50, &c. and lower the ſtyle to 70°, 60°, 50°, &c. and we ſhall have the poſition for theſe ſeveral parts of the mouldboard; and thus it may be formed to the very point of the ſock, becauſe the ſtraight edge of the wreſt may be continued ſo far. A block of wood may be hewed to fit theſe ſeveral poſitions of the protractor ſtyle; and thus, when placed with its ſtraight edge on the outer line of the wreſt, and cut away behind in the land-ſide plane, will be the exact ſhape of the plough-wedge. It would riſe up indeed into a tall piece of ſingular ſhape, gradually tapering down to the point of the ſock; but when cut off parallel to the ground, at the height of about 12 inches, it will form the mouldboard, the front or edge of the ſheath, and the whole back of the ſock except the feather, which is an extraneous piece. The wing or flap of the mouldboard is formed in the ſame manner, by ſliding the ſtock of the protractor to 100, 110, 120, 130, and opening the ſtile to 100°, 110°, 120°, 130°. This will extend the top of the mouldboard to about 22 or 23 inches; but the lower part of the wing muſt be cut away, becauſe it would puſh the ſod too far aſide after it has got the proper twiſt. The form of this part ſhould be ſuch as would exactly apply itſelf to a plank ſet at the heel of the wreſt, parallel to the land ſide of the head, and leaning outward 40 degrees. This will be very nearly the caſe, if it be made a ſweep ſimilar to the edge of the ſheath. Fig. 3. is a reſemblance of the ſurface of the mouldboard: AD being the edge of the ſheath, E the heel of the wreſt, and EBC the wing or flap. When cut through in a perpendicular direction, the ſection is hollow; if cut horizontally it is convex; and if in the direction CE, making an angle of 74° with ED, it is ſtraight. If the protractor be ſet on it at D, and gradually ſlidden backwards, the mouldboard will gradually open the ſtyle, and the ſtyle will ſkim its whole ſurface without any vacuity between them.

Plate XII.

This form is given to the mouldboard on the authority of the ſuppoſition that the ſum of the reſiſtances ariſing from weight and tenacity remains pretty conſtant in its whole length. This cannot be affirmed with confidence in any caſe, and is by no means true in all. In ſtiff clay ſoils the effects of tenacity prevail, and in light or crumbling ſoils the weight is the chief reſiſtance. The advantage of this mode of conſtruction is, that it can be adapted to any ſoil. If the difficulty of cutting and raiſing the ſod is much greater than that of ſhoving it aſide and turning it over, we have only to make the riſe and twiſt more gentle towards the point of the ſock, and more rapid as we advance; and it is eaſy to do this according to any law of acceleration that we pleaſe. Thus, inſtead of dividing the edge of the wreſt DE (fig. 4.) continued to G into 130 parts, draw a line G *g* perpendicular to it, and draw ſome curve line D *g* convex towards DG, and divide this into equal parts in the points 10, 20, 30, 40, &c.; and then draw perpendiculars to the wreſt edge, cutting it in 10, 20, 30, 40, &c. and apply the protractor to theſe points, It is evident that the diviſions of the wreſt-line are bigger at D, and grow gradually leſs towards G; and therefore, becauſe each has 10° more twiſt than the preceding, the twiſt will be more rapid as it approaches the end of the mouldboard. This curve may be choſen ſo as to produce any law of acceleration. On the contrary, we produce a retarded or diminiſhed twiſt by making the curve concave towards DG, as repreſented by the dotted curve.

Plate XII.

The mathematical reader will obſerve, that this conſtruction aims at regulating the twiſt round the line of the wreſt ED. This does not produce preciſely the ſame regulation round the line FD, which is the line of the plough's motion, and of the ſod's poſition before it is ploughed over. The difference, however, is not worth attending to in a matter ſo little ſuſceptible of preciſion.

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ſion. But the twiſt round the line FD may be regulated according to any law by this inſtrument with equal facility. Inſtead of placing the ſtock of the protractor ſquare with the edge of the wreſt, it may be placed ſquare with the land ſide of the plough. To do this, draw a line BL (fig. 8.) acroſs the ſtock from the point B, making the angle LBC 16°, and put a braſs pin at L, making a hole in the ſtyle that it may not be prevented from folding down. Then, in uſing the inſtrument, let the points B and L reſt againſt the edge of the wreſt, and proceed as directed.

Plate XI.

A ſtill greater variety of forms, and accommodation to particular views, with the ſame general dependence on principle, will be procured by giving the rod BA a motion round B in the plane of the ſtyle, ſo as to form a ſtyle of a variable angle.

A tool may even be conſtructed in which the rod BA might be a cutting knife: and the whole may be led along by a ſcrew, while this knife turns round according to any law, and would gradually pare away the mouldboard to the proper form.

Thus have we reduced the faſhioning the operative part of the plough to a rule which is certain. We do not mean by this, that a mouldboard made according to the maxim now given will make the beſt poſſible plough; but we have given a rule by which this part of the plough can be made unequivocally of a certain quality by every workman, whatever this quality may be, and this without being obliged to copy. No deſcription of any curve mouldboard to be met with in books has this advantage; and we ſay that this rule is capable of any ſyſtematic variation, either with reſpect to the width of furrow, or the quantity or variation of its twiſt. We have therefore put it in the power of any intelligent perſon to make ſuch gradual and progreſſive changes as may ſerve to bring this moſt uſeful of all inſtruments to perfection. The angle of the head and wreſt, and the curve for dividing the wreſt-line, can always be expreſſed in writing, and the improvements communicated to the public at large.

Method of the plough's action.

After this deſcription of the working parts of a plough, and directions for giving it the moſt effective form, it will not be improper to conſider a little its mode of action, with the view of attaining a more diſtinct conception of what is done by the ploughman and the cattle, and to direct him in his procedure.

Plate XI.

Returning again to the wedge (fig. 1.), we ſee that it is preſſed down at the point D, and as far back along the mouldboard as its ſurface continues to look upward, that is, all the way to the heel of the wreſt. Behind this, the perpendicular ſections of the mouldboard overhang, and look downward; and here, while preſſing down the ſod, the plough is preſſed upwards. Theſe two preſſures tend to twiſt the plough round a tranſverſe line ſomewhere between the heel and the point. The plough therefore tends to riſe at the heel, and to run its point deeper into the ground. Upon the whole, the preſſure downwards is much greater than the upward preſſure. It is exerted over a much greater ſpace, and is greater in moſt parts of that ſpace. Behind, very little downward preſſure is neceſſary, the ſod being ready to fall down of itſelf, and only requiring a gentle touch to lay it in a proper poſition.

In like manner the plough is preſſed backward by the reſiſtance made to the coulter and ſock, and part of the reſiſtance made to the ſloping ſide of the mouldboard:

and

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and it is preſſed to the left by the other part of the preſſure on the ſock and mouldboard.

All theſe preſſures muſt be balanced by the joint action of the cattle, the reſiſtance of the bottom, and the reſiſtance of the firm ground on the left hand or land ſide.

It is the action of the cattle, exerted on that point to which they are attached, which produces all theſe preſſures. It is demonſtrated by the principles of mechanics, that this force muſt not only be equal to the mean or compound force of theſe reſiſting preſſures, but muſt alſo be in the oppoſite direction,

It is further demonſtrated, that if a body be dragged through any reſiſting ſubſtance by a force acting on any point G, and in any direction whatever GH, and really moves uniformly in that direction, the force exerted exactly balances the reſiſtances which it excites, both as to quantity and direction: And if the body advances without turning round the point by which it is dragged, the reſiſtances on one ſide of this point are in equilibrio with thoſe on the oppoſite ſide.

And, laſtly, it is demonſtrated, that when this equilibrium is obtained, it is indifferent to what point in the line GH the force is applied. Therefore, in fig. 3. the force acting in the direction HO may either be applied to the point of the beam H, or to the point N of the coulter, or to the point O of the ſock.

Plate XII.

When therefore a plough advances ſteadily, requiring no effort of the ploughman to direct it, if the line of draught OM (fig. 5.) be produced backwards to the point G of the mouldboard, that point is the place round which all the reſiſtances balance each other. This

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This point may be called the *centre of reſiſtance* and the *centre of action.*

It would be of importance to determine this point by principle; but this can hardly be done with preciſion even in a plough of a known form: and it is impoſſible to do it in general for all ploughs, becauſe it is different in each. It even varies in any plough by every variation of the proportion between the weight and the coheſion of the ſod. We ſee how it can be found experimentally in any given uniform ſod, viz. by producing backwards the line of draught. Then, if the draught rope, inſtead of being fixed to the muzzle of the beam, were fixed to this point, and if it were pulled in the ſame direction, the plough would continue to perform its work without any aſſiſtance from the ploughman, while the ſod continued uniform. But the ſmalleſt inequality of ſod would derange the plough ſo as to make it go entirely out of its path. Should the reſiſtances between G and D prevail, the plough would go deeper, which would increaſe the reſiſtances on that ſide where they already exceed, and the plough would run ſtill deeper. Should the reſiſtances behind G prevail, the heel would be preſſed down, and the point would riſe, which would ſtill farther deſtroy the equilibrium, and, producing a greater deviation from the right path, would quickly throw the plough out of the ground.

For theſe reaſons we muſt not think of attaching the draught to the centre of reſiſtance; but muſt contrive a point of draught, ſuch as ſhall reſtore the plough to its proper poſition when it has been driven out of it by any obſtruction.

Muzzle of the beam.

The muzzle or end of the beam is a point which will

Plate XII.

completely ſuit our purpoſe. *For ſuppoſe that the reſiſtance on the back of the ſock has prevailed, and the plough* MNFD (fig. 5.) has taken the poſition *m n f d* repreſented by the dotted lines, the draught line GMO is brought down into the poſition *g m o*, diverging a little from GMO, and meeting the mouldboard in a point *g* conſiderably before G. By this means the reſiſtances on the hinder ſide of *g* are increaſed, and thoſe before it are diminiſhed, and the plough quickly regains its former poſition.

The point of draught.

From theſe obſervations it is plain, that whatever is the ſituation of the centre of reſiſtance, the point of draught may be ſo choſen that the action of the cattle ſhall be directly oppoſed to the reſiſtance of the ground, and that moreover the plough ſhall have no tendency either to go deeper or to run out. This is the uſe of the apparatus at the point of the beam called the muzzle, repreſented at H (fig. 4.) It turns round a bolt *i* through the beam, and can be ſtopped at any height by another pin *k* put through the holes in the arch *l m*. A figure is given of the muzzle immediately below, as it appears when looking down on it. The eye to which the draught rope is hooked is ſpread out horizontally, as ſhown by HK, and has ſeveral notches O in it, to either of which the hook can be applied. This ſerves to counteract any occaſional tendency which the plough may have to the right or left.

Plate XI.

When the plough goes on ſteadily, without any effort of the ploughman, it is ſaid to be in trim, and to ſwim fair; the preſſure before and behind the centre of action being in equilibrio with each other. In order to learn whether a plough will be in this manner under management, hook the draught rope as high as poſſible.

Of the plough in trim.

In this ſtate the plough ſhould have a continual tendency to riſe at the heel, and even to run a little into the ground. Then hook the rope as low as poſſible. The plough ſhould now preſs hard on the furrow with the heel, and have ſome tendency to run out of the ground. If both theſe are obſerved, the plough is properly conſtructed in this reſpect; if not, it muſt be altered, either by changing the poſition of the ſock or that of the beam. Lowering the end of the beam will correct the tendency of the plough to go deeper; the raiſing the point of the ſock will alſo have the ſame effect. But it is of conſiderable importance not to take the point of the ſock out of the plane of the ſod, and it is much better to make the alteration by the beam. The ſlope of the coulter has a conſiderable effect, but it cannot be placed very far from the inclination of 45° without the riſk of choking the plough by driving the roots and ſtones before it. It is of great conſequence to have the coulter fit exactly in the direction of the plough's motion; if it is in any other direction, it will powerfully twiſt the plough into its own track. As it muſt be fixed in the middle of the beam's thickneſs to have ſtrength, it is removed a little from the plane of the land ſide, and it was the uſual practice to point it to the left below to compenſate for this; but this by no means removes the diſpoſition to twiſt, and it expoſes to the riſk of catching a ſtone between its point and that of the ſock, which muſt now be driven forward through the firm ground at a great expence of labour to the cattle. Mr Small has very ingeniouſly remedied this, by giving the coulter a ſhort knee to the left immediately below the beam, and thus point-ing it downwards in the plumb of the land ſide. See fig. 1. Plate XII.

It is not without its uſe to know the abſolute force neceſſary for tilling the ground. This has been frequently meaſured with a ſpring ſteelyard. One of Small's ploughs worked by two horſes, [illegible] employed in breaking up ſtiff land which had been ploughed before winter, and much conſolidated by the rains, required a force of 360lbs. avoirdupois; and we may ſtate this as the ordinary rate of ſuch work; but moderately firm ſod, under good culture, requires at a medium 320lbs.

As we wiſh to embrace every opportunity of rendering this work uſeful to the public, we ſhall conclude this article with an account of a plough which has been recommended to public notice by the Scots Highland Society as extremely proper for a hilly country. The inventor, the Rev. Alexander Campbell miniſter of Kilcalmonill in Argyleſhire, was honouredwith the Society's gold medal, value 25l.

Plate XII. The Argyleſhire plough.

A, the ſock (fig. 6.); the land ſide of which ſupplies the place of the coulter, and the ſole of it ſerves for a feather; it is 18 inches long, and is made of a plate of iron 12 inches broad when finiſhed, and ſomewhat under half an inch thick.—B, the head; to be made of iron in a triangular form, 4 inches broad by 2 inches at the thickeſt part. There are 5 inches of the head fixed in the ſock.—C, the beam, 4 inches thick by 5 inches deep, gradually tapered thinner; the length 6 feet.—E, the ſheath, muſt be of the ſame thickneſs with the beam above and the head below, and is 5 inches broad. An iron ſcrew-bolt connects the beam and head behind the ſheath.—F, the handles are ſo

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made that the ſlope of the mouldboard, which is fixed [illegible] of them, may be the longer and more gradual. [illegible] are 5 feet 8 inches long, and 2 feet 4 inches aſunder at the ends.——G, the mouldboard, conſiſts of 7 rounded ſticks 2 inches in diameter; the covert of them is in the plane of the ſole, the reſt in ſucceſſion cloſe to each other above it. This makes the mouldboard 14 inches broad. To prevent any earth from getting over the mouldboard, a thin deal 4 or 5 inches broad is fixed above it. The mouldboard, land-ſide, and ſole of the plough, are clad with iron.—The length is 20 inches: this added to 18 inches, the length of the ſock, makes the length from point to heel 3 feet 2 inches.—The muzzle or bridle OPH is alſo of a more convenient and better conſtruction than thoſe commonly in uſe. By means of the ſcrew pins at L and M different degrees of land may be given to the plough; the iron rod LH being thereby moved ſidewiſe in the ſocket LN, and up and down by OP. The rod is 30 inches long, one broad, and half an inch thick. It is hooked into a ſcrewbolt at H. Two inches of the rod project at N, in the form of an eye, before the muzzle, to receive the hook of the croſstree.

The advantages of this plough are ſaid to be: It is not ſo liable to be interrupted or turned out of its courſe by ſtones, roots, &c. as other ploughs are; nor does it dip ſo deep as to be liable to be broken by large ſtones or flags. The motion of the muzzle is alſo thought an improvement. Another advantage it has over other ploughs is, its not being ſo liable to be choked up by ſtubble, &c. This we underſtand to be its chief excellency, and an object much deſired in the conſtruction of the plough. Upon the whole, we are informed, that this plough is lighter, leſs expenſive, and leſs liable to go out of trim, than the ordinary plough, and that with it two horſes can plough land which requires four with any other plough.

Objections to its conſtruction.

Such are ſaid to be the advantages of this conſtruction; but we cannot help expreſſing our apprehenſion, that the uniting the coulter and feather at the point of the ſock will expoſe the plough to great riſks of being put out of order. When the upright edge ſtrikes a ſtone obliquely, eſpecially on the landſide, it muſt be violently twiſted round the point of the head; and, having but a moderate thickneſs at this part, may be broken or permanently twiſted. The plough will then be continually running out of its direction: and we apprehend that this defect cannot be amended without taking off the ſock and putting it in the fire. When a coulter is bent by the ſame cauſe, the ploughman can either rectify it by altering the wedging, or he can ſtraighten it in the field; and it muſt be obſerved, that the plough oppoſes much leſs reſiſtance to the derangement of this ſort of coulter than of the common one. In the common coulter the ſtrain does not ſo much tend to twiſt the plough round the line of its motion, as to preſs it wholly to landward. The reſiſtance to this is great; but a very moderate force will twiſt it round its line of motion. In either caſe, if the blow be given in that point of the coulter where the draught line croſſes it, there will be no twiſt of the whole plough, but the point of the plough will be forced horizontally to or from the land. When the blow is out of this line, the ſtrain tends to twiſt the beam or the plough. Experience will determine which of the two is the moſt hazardous.

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hazardous. Models of theſe ploughs are to be ſeen in the hall of the Highland Society.

Scots plough.

The plough conſtructed in the following manner is ſtill the moſt common and the moſt generally underſtood in Scotland; and, if properly made, is the beſt for anſwering all purpoſes, when only one is uſed; though others are, perhaps, more proper on ſome particular occaſions.

Deſcription of the Scots plough.

The parts of which this plough is compoſed, are, the head, the beam, the ſheath, the wreſt, the mouldboard, the two handles, the two rungs, the ſock, and the coulter; the two laſt are made of iron, and all the reſt of wood.

Plate I. fig. 1.

The HEAD is deſigned for opening the ground below. The length of the head from A to B is about 20 inches, and the breadth from A to D above five inches; C is the point upon which the ſock is driven, and the length from B to C is about ſix inches; *a* is the mortiſe into which the larger handle is fixed, and *b* is the mortiſe into which the ſheath is fixed.

The head is that part of the plough which goes in the ground; therefore the ſhorter and narrower it is, the friction will be the leſs, and the plough more eaſily drawn; but the longer the head is, the plough goes more ſteadily, and is not ſo eaſily put out of its direction by any obſtructions that occur. Twenty inches is conſidered as a mean length; and five inches as the moſt convenient breadth.

Fig. 2.

The SHEATH E is driven into the mortiſe B, and thus fixed to the head A B. It is not perpendicular to the head, but placed obliquely, ſo as to make the angle formed by the lines AB and EB about 60 degrees. The ſheath is about 13 inches long, beſides what is driven into the mortiſe *b* (fig. 1.); about three inches broad, and one inch thick.

The ſheath is fixed to the mouldboard, as in Plate II. fig. 5. E, in the ſame manner as the wreſt is fixed to the head in Plate I. fig. 4.

The MOULDBOARD is deſigned to turn over the earth of the furrow made by the plough; and it is obvious, that, according to the poſition of the ſheath, the mouldboard will turn over the earth of the furrow more or leſs ſuddenly. Beſides, when it forms a leſs angle with the head than 60 degrees, the plough is in great danger of being *choked*, as the farmers term it.

Plate I. Fig. 3. The larger HANDLE, FA, is fixed to the head, by driving it into the mortiſe *a* (fig. 1.) It is placed in the ſame plane with the head; and its length from AF is about five feet four inches, and its diameter at the place where it is fixed to the beam is about two inches and a half, and tapers a little to the top F. About ten inches from A, there is a curve in the handle, which, when F is raiſed to its proper height, makes the lower part of it nearly parallel to the ſheath EB. This curve is deſigned to ſtrengthen the handle. The proper poſition to the handle is, when the top F is about three feet two inches higher than the bottom of the head AB.

The longer the handles, the plough is the more eaſily managed, becauſe the levers are more diſtant from the centre of motion. The higher the top of the handles, the plough is the more eaſily raiſed out of the ground, provided they be no higher than the lower part of a man's breaſt.

Fig. 6. The BEAM is fixed to the larger handle and the ſheath, all of which are placed in the ſame plane with the

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the head. The length of it, from H to I, is about ſix [illegible] diameter is about four inches. When the plough is in the ground, the beam ſhould be juſt high enough not to be incommoded by any thing on the ſurface.

The poſition of the beam depends on the number of cattle in the plough. When two horſes are yoked, the beam ſhould be placed in ſuch a manner as to make the perpendicular diſtance betwixt the bolt-hole of the beam and the plane of the head about 21 inches; when four horſes are yoked, two a-breaſt, this diſtance ſhould only be about 18 inches.

Plate I. Fig. 3.

The SOCK, BP, is fixed to the end of the head, and is about two feet long. In fitting the ſock to the head, the point ought to be turned a little to the land or left ſide; becauſe otherwiſe it is apt to come out of the land altogether. When turned to the left, it likewiſe takes off more land; when turned upwards, the plough goes ſhallow; and when downwards, it goes deeper.

Fig. 8.

The COULTER is fixed to the beam, and is about two feet ten inches long, two inches and a half broad, ſharp at the point and before, and thick on the back, like a knife. It is fixed and directed by wedges, ſo as to make the point of it equal to, or rather a little before, the point of the ſock, and upon a line with the left ſide of the head. This oblique poſition enables it to throw roots, &c. out of the land, which requires leſs force than cutting or puſhing them forward.

Fig. 7.

The WREST, BD, is fixed to the head, and is about 25 inches long, two broad, and one thick. It is fixed to the head at B, in ſuch a manner as to make the angle contained between the lines AB and BD about 25 degrees.

grees. The wreſt is ſeldom or never placed in the ſame plane with the head, but gradually raiſed from [illegible], where it is fixed to it; that is, from B to K, as in fig. 7. The poſition of the wreſt determines the nature of the furrow. When the wreſt is wide and low ſet, the furrow is wide; and when it is narrow and high ſet, the furrow is narrow.

Plate II.

Fig. 1. repreſents the two HANDLES, fixed together by the two rungs. The larger handle has already been deſcribed; the leſſer one is a few inches ſhorter, and does not require to be quite ſo ſtrong. The diſtance of the handles at the little rung depends on the poſition of the wreſt. Their diſtance at M and P is about two feet ſix inches. The leſſer handle is fixed to the mould-board at M, fig. 4. and to the wreſt KB, at L.

Fig. 5. repreſents the plough complete, by joining together fig. 8. Plate I. and fig. 4. Plate II. in the ſheath EB. The wreſt BK is ſuppoſed to make an angle with the head AB as in Plate I. fig. 4. and the handles joined together as in Plate II. fig. 1.

After having given ſuch a particular deſcription of all the parts and proportions of the Scots plough, it will eaſily appear how it ſeparates, raiſes, and turns over the earth of the furrow. If it had no coulter, the earth would open above the middle of the ſock, and in a line before the ſheath; but as the coulter opens the earth in a line with the left ſide of the head, if the ſoil has any coheſion, the earth of the furrow will be wholly raiſed from the left ſide, and, as the ſock moves forward, will be thrown on the right ſide of the ſheath, and by the caſting out of the mouldboard, or the raiſing of the wreſt, will be turned over.

Plate II. Fig. 6.

The BRIDLE, or MUZZLE, is another article belonging

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ing to the plough. It is fixed to the end of the beam, and the cattle are yoked by it. The muzzle commonly uſed is a curved piece of iron, fixed to the beam by a bolt through it. ABC is the muzzle, AC the bolt by which it is fixed to the beam; D is the ſwingle-tree or croſs-tree, to which the traces are fixed; and B is a hook, or *cleek*, as it is commonly called, which joins the muzzle and ſwingle-tree.

Plate II. Fig. 2.

Some uſe another kind of muzzle, ABCD. It is fixed to the beam by two bolts, and has notches by which the cleek of the ſwingle-tree may be fixed either to the right or the left of the beam. There are alſo different holes for the hind bolt to paſs through, by which the draught may be fixed either above or below the beam. AD is the fore bolt upon which the muzzle turns; on BC are four notches, betwixt any two of which the cleek of the ſwingle-tree may be fixed. When the cleek is fixed at B, the plough is turned towards the firm land, and takes off a broader furrow; and when fixed at C, it is turned towards the ploughed land, and takes off a narrower furrow. E and F are the holes on each ſide through which the hindmoſt bolt paſſes. When the bolt is put through the higheſt two, theſe holes being thereby brought to the middle of the beam, the fore part of the muzzle is raiſed above the beam, and the plough is made to go deeper; and when put through the loweſt two, the fore part of the muzzle is ſunk below the beam, and the plough is made to go ſhallower. This muzzle may be ſo conſtructed as to have the ſame play with the common one.

Fig. 10.

A is the end of the beam; B a plate of iron ſunk into it, and, with a ſimilar one in the other ſide, is rivetted into it by bolts; C is the muzzle fixed to theſe plates of iron by a bolt, which bolt may be put through any of the holes marked on the plate B. From the conſtruction of this muzzle it is plain, that it has the ſame play with the common one, and that by it the land of the plough may be altered at pleaſure.

Properties of the Scots plough.

Of all forms, that of the Scots plough is the fitteſt for breaking up ſtiff and rough land, eſpecially where ſtones abound; and no leſs fit for ſtrong clays hardened by drought. The length of its head gives it a firm hold of the ground; its weight prevents it from being thrown out by ſtones; the length of the handles gives the ploughman great command to direct its motion; and by the length of its head, and of its mouldboard, it lays the furrow-ſlice cleverly over. This plough was contrived during the infancy of agriculture, and was well contrived: in the ſoils above deſcribed it has not an equal.

In what ſoil improper.

But in tender ſoil it is improper, becauſe it adds greatly to the expence of ploughing, without any counterbalancing benefit. The length of the head and mouldboard increaſes the friction, and conſequently it requires a greater number of oxen or horſes than are neceſſary in a ſhorter plough. There is another particular in its form that reſiſts the draught: the mouldboard makes an angle with the ſock, inſtead of making a line with it gently curving backward. There is an objection againſt it no leſs ſolid, that it does not ſtir the ground perfectly: the hinder part of the wreſt riſes a foot above the ſole of the head: and the earth that lies immediately below that hinder part, is left unſtirred. This is ribbing land below the ſurface, ſimilar to what is done by ignorant farmers on the ſurface.

Theſe defects muſt be ſubmitted to in a ſoil that re-

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quires a ſtrong heavy plough; but may be avoided in a cultivated ſoil by a plough differently conſtructed. Of all the ploughs fitted for a cultivated ſoil free of ſtones, that already mentioned, which was introduced into Scotland about 20 years ago, by James Small in Blackadder mount, Berwickſhire, is the beſt. It is now in great requeſt; and with reaſon, as it avoids all the defects of the Scots plough. The ſhortneſs of its head and of its mouldboard leſſen the friction greatly: from the point of the ſock to the back part of the head it is only 30 inches; and the whole length, from the point of the beam to the end of the handles, between eight and nine feet. The ſock and mouldboard make one line gently curving; and conſequently gather no earth. Inſtead of a wreſt, the under edge of the mouldboard is one plane with the ſole of the head; which makes a wide furrow, without leaving any part unſtirred. It is of late commonly termed the *chain-plough*, becauſe it is drawn by an iron chain fixed to the back part of the beam immediately before the coulter. This has two advantages: firſt, by means of a muzzle, it makes the plough go deep or ſhallow; and, next, it ſtreſſes the beam leſs than if fixed to the point, and therefore a ſlenderer beam is ſufficient.

Chain-plough. Plate III. fig. 1.

As we have already ſufficiently explained the ſpeculative principles upon which this plough is formed, we ſhall only remark, that it is proper for loams, for carſe clays, and, in general, for every ſort of tender ſoil free of ſtones. It is even proper for opening up paſture ground, where the ſoil has been formerly well cultivated.

A ſpiked ſock is uſed in the Scots plough. The difference between it and the feathered ſock will be beſt

Of the ſock. Plate II.

beſt underſtood by comparing their figures. Fig. 7. is the common ſock, and fig. 3. the feathered one.

From the conſtruction of the feathered ſock, it is obvious, that it muſt meet with greater reſiſtance than the common ſock. However, when the plough takes off the earth of the furrow broader than that part of the ſock which goes upon the head, it is more eaſily drawn than the plough with the common ſock; for the earth which the common ſock leaves to be opened by the wreſt, is more eaſily opened by the feather of the other ſock. In ley, the feathered ſock makes the plough go more eaſily, becauſe the roots of the graſs, which go beyond the reach of the plough, are more eaſily cut by the feather than they can be torn aſunder by the common ſock. The feathered ſock is alſo of great uſe in cutting and deſtroying root weeds. The common ſock, however, anſwers much better in ſtrong land.

It is proper here to add, that in fitting the feathered ſock to the head, the point of it ſhould be turned a little from the land, or a little to the right hand.

A chain-plough of a ſmaller ſize than ordinary, drawn by a ſingle horſe, is of all the moſt proper for horſe-hoeing, ſuppoſing the land to be mellow, which it ought to be for that operation. It is ſufficient for making furrows to receive the dung, for ploughing the drills after dunging, and for hoeing the crop.

A ſmall ſingle-horſe plough recommended for various purpoſes.

A ſtill ſmaller plough of the ſame kind may be recommended for a kitchen garden. It can be reduced to the ſmalleſt ſize, by being made of iron; and where the land is properly dreſſed for a kitchen garden, an iron plough of the ſmalleſt ſize drawn by a horſe will

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ſave much ſpade-work. In Scotland, forty years ago, a kitchen garden was an article of luxury merely, becauſe at that time there could be no cheaper food than oatmeal. At preſent, the farmer that maintains his own ſervants does it at double expence, as the price of oatmeal is doubled; and yet he has no notion of a kitchen garden more than he had thirty years ago. He never thinks, that living partly on cabbage, kail, turnip, carrot, would ſave much oatmeal; nor does he ever think, that change of food is more wholeſome, than vegetables alone, or oatmeal alone. We need not recommend potatoes, which in ſcanty crops of corn have proved a great bleſſing: without them, the labouring poor would frequently have been reduced to a ſtarving condition. Would the farmer but cultivate his kitchen garden with as much induſtry as he beſtows on his potato crop, he needed never fear want; and he can cultivate it with the iron plough at a very ſmall expence. It may be held by a boy of 12 or 13; and would be a proper education for a ploughman. But it is the landlord who ought to give a beginning to the improvement. A very ſmall expence would encloſe an acre for a kitchen garden to each of his tenants; and it would excite their induſtry, to beſtow an iron plough on thoſe who do beſt.

Nor is this the only caſe where a ſingle horſe plough may be profitably employed. It is ſufficient for ſeed-furrowing barley, where the land is light and well-dreſſed. It may be uſed in the ſecond or third ploughing of fallow, to encourage annual weeds, which are deſtroyed in ſubſequent ploughings.

Rotheram Plough, Plate V. fig. 3.

The *Rotheram plough* is a machine of very ſimple conſtruction, and eaſily worked. AB is the beam, CD the ſheath, EBD the main handle, FR the ſmaller

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handle, GH the coulter, KI the ſock or ſhare, NP the bridle, S the fly-band, and ML a piece of wood in place of a head. The whole of this plough ſhould be made of aſh or elm; the irons ſhould be ſteeled and well tempered; and that part of the plough which is under ground in tilling ſhould be covered with plates of iron. The difference between this and the common plough ſeems to conſiſt in the bridle at the end of the beam, by which the ploughman can give the plough more or leſs land by notches at N, or make it cut deeper or ſhallower by the holes at P; in the coulter or ſhare, which are ſo made and ſet as to cut off the new furrow without tearing; and in the mouldboard, which is ſo ſhaped as at firſt to raiſe a little, and then gradually turn over, the new cut furrow, with very little reſiſtance. But the greateſt advantage attending it, is its being ſo eaſy of draught, that it will do double the work of any common plough.

The Paring Plough, Plate V. fig. 4.

The *paring plough* is an inſtrument uſed in ſeveral parts of England for paring off the ſurface of the ground, in order to its being burnt. Mr Bradley has given the following very perſpicuous deſcription of this inſtrument: From A to A is the plough-beam, about ſeven feet long, mortiſed and pinioned into the block B, which is of clean timber without knots. CC are the ſheaths or ſtandards, made flat on the inſide, to cloſe equally with the paring plate, and faſtened to it with a bolt and key on each ſide, as at D. E is the paring plate of iron laid with ſteel, about four inches wide, and from 12 to 18 inches long. This plate muſt be made to cut on the ſides, which are bolted to the ſtandards as well as at the bottom part. FF are two iron braces to keep the ſtandards from giving

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ing way: theſe ſtandards muſt be mortiſed near their outſides, and through the block. GG are the plough handles, which muſt be fixed ſlopeways between the beam and the ſtandards. The pin holes in the beam, the uſe of which is to make this plough cut more or leſs deep, by fixing the wheels nearer to or farther from the paring plate, ſhould not be above two inches aſunder.

The Four-coultered Plough, Plate V.

Fig. 1. repreſents the four-coultered plough of Mr Tull. Its beam is ten feet four inches long, whereas that of the common plough is but eight. The beam is ſtraight in the common plough, but in this it is ſtraight only from *a* to *b*, and thence arched; ſo that the line let down perpendicularly from the corner at *a* to the even ſurface on which the plough ſtands, would be 11½ inches; and if another line were let down from the turning of the beam at *b* to the ſame ſurface, it would be one foot eight inches and a half; and a third line let down to the ſurface from the bottom of the beam at that part which bears upon the pillow, will ſhow the beam to be two feet ten inches high in that part. At the diſtance of three feet two inches from the end of the beam *a*, at the plough-tail, the firſt coulter, or that next the ſhare, is let through; and at 13 inches from this, a ſecond coulter is let through: a third at the ſame diſtance from that; and, finally, the fourth at the ſame diſtance from the third, that is, 13 inches, and from *a* to *b* is ſeven feet.

The crookedneſs of the upper part of the beam of this plough is contrived to avoid the too great length of the three foremoſt coulters, which would be too much if the beam was ſtraight all the way; and they would be apt to bend and be diſplaced, unleſs they

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were very heavy and clumſy. Aſh is the beſt wood to make the beam of, it being ſufficiently ſtrong, and yet light. The ſheat in this plough is to be ſeven inches broad. The fixing of the ſhare in this, as well as in the common plough, is the niceſt part, and requires the utmoſt art of the maker; for the well-going of the plough wholly depends upon the placing this. Suppoſing the axis of the beam, and the left ſide of the ſhare, to be both horizontal, they muſt never be ſet parallel to each other; for if they are, the tail of the ſhare bearing againſt the trench as much as the point, would cauſe the point to incline to the right hand, and it would be carried out of the ground into the furrow. If the point of the ſhare ſhould be ſet ſo, that its ſide ſhould make an angle on the right ſide of the axis of the beam, this inconvenience would be much greater; and if its point ſhould incline much to the left, and make too large an angle on that ſide with the axis of the beam, the plough would run quite to the left hand; and if the holder, to prevent its running quite out of the ground, turns the upper part of his plough towards the left hand, the pin of the ſhare will riſe up, and cut the furrow diagonally, leaving it half unploughed. To avoid this and ſeveral other inconveniences, the ſtraight ſide of the ſhare muſt make an angle upon the left ſide of the beam; but that muſt be ſo very acute a one, that the tail of the ſhare may only preſs leſs againſt the ſide of the trench than the point does. This angle is ſhown by the pricked lines at the bottom of fig. 9. where *ef* is ſuppoſed to be the axis of the beam let down to the ſurface, and *g f* parallel to the left ſide of the ſhare: and it is the ſubtenſe *e g* that determines the inclination which the point of the ſhare muſt have towards the left hand. This ſubtenſe, ſays Mr Tull, at the fore-end of an eight-feet beam, ſhould never be more than one inch and a half, and whether the beam be long or ſhort, the ſubtenſe muſt be the ſame.

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The great thing to be taken care of, is the placing the four coulters; which muſt be ſo ſet, that the four imaginary places deſcribed by their four edges, as the plough moves forward, may be all parallel to each other, or very nearly ſo; for if any one of them ſhould be very much inclined to, or ſhould recede much from, either of the other, then they would not enter the ground together. In order to place them thus, the beam muſt be carefully pierced in a proper manner. The ſecond coulter-hole muſt be two inches and a half more on the right hand than the firſt, the third muſt be as much more to the right of the ſecond, and the fourth the ſame meaſure to the right hand of the third; and this two inches and a half muſt be carefully meaſured from the centre of one hole to the centre of the other. Each of theſe holes is a mortiſe of an inch and a quarter wide, and three inches and a half long at the top, and three inches at the bottom. The two oppoſite ſides of this hole are parallel to the top and bottom, but the back is oblique, and determines the obliquity of the ſtanding of the coulter, which is wedged tight up to the poll. The coulter is two feet eight inches long before it is worn; the handle takes up ſixteen inches of this length, and is allowed thus long, that the coulter may be driven down as the point wears away. As to the wheels, the left-hand wheel is 20 inches diameter, and that on the right hand two feet three inches, and the diſtance at which they are ſet from each other is two feet 5½ inches.

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2. *The Patent Sward-cutter.*

Patent Sward-cutter, Plates VI. and IX.

The different parts of this inſtrument are repreſented by fig. 6. Plate VI. and fig. 1. and 2. Plate IX. AA, &c. a ſquare frame three feet four inches from the fore to the hind part, by four feet three inches, the breadth of the machine within ſide; the timber (when of fir) four inches ſquare, placed on two wheels BB three feet diameter, a little more or leſs (the old fore-wheels of a chaiſe may anſwer the purpoſe), to ſupport the hind part of the machine.

CC, &c. are ſix ſtrong pieces of wood, called *bulls*, three feet long, five inches and a half broad, the thickneſs ſix inches at E, and tapering to three inches at F. Into theſe bulls are fixed the cutting wheels, which are iron, 13 inches diameter, $\frac{3}{4}$ths of an inch thick at the centre, about an inch diameter, for piercing holes to fix the iron axles in; from that they are to be of ſuch thickneſs, as to allow the edges to be well ſteeled. The wheels are fixed by two bolts going through the bulls, with eyes on one end for the axles of the wheels to run in, and nuts and ſcrews on the other to make them very firm by being ſunk in the bulls, to prevent their interfering with the weights LL, &c. reſting on them.

GG, &c. are hollow pieces of wood, called *thorles*, each 3½ inches long, which encloſe the bolt MM, and keep the bulls CC, &c. at their proper diſtances, but may be made longer or ſhorter at pleaſure, according as the ſward requires to be cut in larger or ſmaller pieces. They are in two pieces bound together, and jointed by a ſtrap of leather or cord, which allows them to be readily changed when the cutting wheels require to be kept at more or leſs diſtance.

The iron bolt MM goes through two pieces of wood or iron PP, ſeven inches long, clear of the wood, ſupported by iron ſtays fixed to the frame, and through all the bulls. It requires to be ſtrong, as the draught of the horſes terminates there.

Plate IX.

HH, fig. 1. and 2. a cylinder or ſegment of wood, ſeven inches diameter, called a *rocking-tree*, which goes acroſs the frame, and moves on the pivots fixed into it, one at each end, ſupported by an iron bolt or piece of wood mortiſed into the frame, eight inches high, as appears in fig. 1. and 2. to which ſix chains or ropes are fixed by hooks, at different diſtances, as you want your cuts, nine, eight, ſeven, or ſix inches from one another, and are joined to the end of each bull in which the cutting wheels run; ſo that when the rocking-tree is turned about by the lever I, fixed in the middle of it, all the bulls, with their cutting wheels, are raiſed out of the ground at once, as in N° 3. by which means the machine may be turned, or moved from place to place with great eaſe, without any danger of ſtraining the wheels.

LLL, &c. fig. 6. Plate VI. and fig. 1. 2. Plate IX. are weights of freeſtone, 26 inches long and ſix inches broad; the under one four inches thick, the upper one three inches thick; weighing about 64lb. the under, and 48 the upper, each of them having two holes, through which iron ſpikes, firmly fixed in the bulls, paſs, in order to keep them ſteady.

When the ground is eaſily cut, the under ſtone may anſwer; when more difficult, the other ſtone may be added; ſo that every wheel may have ſeven ſtone weight upon it, which has been found ſufficient for the ſtiffeſt land and tougheſt ſward the machine has ever

been

been tried on. Caſt iron weights will anſwer fully better, but are more expenſive.

Plate IX.

The lever I, fig. 1. 2. which ought to be five feet long, muſt have a ſliding rope on it; fixed to the back part of the frame; ſo that when the cutting wheels are all taken out of the ground three or four inches, by the rocking tree's being turned partly round by the lever, the rope may be fixed to it by a loop over the pin R, fig. 2. (it ought to be placed three feet four inches from the extremity of the lever I.) Thus all the cutting wheels are kept out of the ground till the machine is turned; and then by moving the loop off the pin, it ſlips back towards the frame, and the lever is gently let back to its place, as in fig. 1. by which the cutting wheels are put into their former poſture, by the weights fixed on the bulls in which they run. The levers may be made of good tough aſh.

Plate VI.

PP, fig. 6. a ſmall bolt of iron, with a hook on one end of it (one is ſufficient), to ſtrengthen the bolt MM to be hooked on the centre of it, and joined to the frame by a nut and ſcrew.

The grooves in which the cutting wheels run, may be covered below at the hinder part with a plate of thin black iron, 6 inches long, 3 inches broad, having a ſlit in it where the wheels run, to prevent (if found neceſſary) any graſs, weeds, or ſmall ſtones, from filling the grooves, and clogging the wheels.

To the frame fig. 6. are fixed (for a double-horſe ſward-cutter) three ſhafts, as in a waggon, of ſuch length, ſtrength, and diſtance from one another, as any workman many think proper.

For a ſingle-horſe ſward-cutter (which has only four cutting wheels), a pair of ſhafts are uſed, and may

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make the two ſides of the frame without any joinings. The width of the frame, in proportion to the double-horſe ſward-cutter, is as four to ſix.

It is recommended for a double-horſe ſward-cutter to have eight bulls and wheels, in order that when it is uſed to reduce hard clody ſummer-fallow, or land for barley, before the laſt furrow, or even after it, the whole weight (42 ſtone) employed in cutting the ſtiffeſt land and tougheſt ſward, may be applied to the 8 bulls then at 6 inches from one another. The 64lb. weights to be applied to 6 of the bulls, and two of the 48lb. weights to each of the additional bulls, which is a ſufficient weight for that purpoſe, and will effectually prevent a clod of more than ſix inches breadth from eſcaping being broke into pieces.

In the ſame manner, a ſingle-horſe ſward-cutter may have ſix bulls for the above-mentioned purpoſe; the 28 ſtone belonging to it divided thus: The 64lb. weights to four of the bulls, and two of the 48lb. weights to each of the additional bulls.

That the machine may come as cheap as poſſible to the public, the inventor is of opinion, that the expence of the two wheels and the iron axle (which is conſiderable) may be ſaved, by joining ſtrongly to the frame a piece of wood with a little curve at the extremity of it, reſembling the foot of a ſledge formerly much uſed in Scotland to carry in the corn from the field; the part of it reſting on the ground being kept 18 inches (the half diameter of the wheels) from the frame by a ſtrong ſupport of wood.

As the two outer bulls next the frame are apt to get under it, ſo as to prevent the cutting wheels from being taken out of the ground, a thin ſlip of iron fixed to the inſide of the frame, nearly oppoſite to the back end of the bulls, of convenient length, will be found neceſſary.

The original intention of this machine was to prepare old graſs ground for the plough, by cutting it acroſs the ridges, in the beginning of or during winter, when the ground is ſoft, in order to anſwer all the purpoſes that Mr Tull propoſed by his four-coulter plough above deſcribed, and ſo ſtrongly recommended by him for bringing into tilth graſs ground that has been long reſted. This the ſward-cutter has been found to do much more effectually and expeditiouſly: For Mr Tull's machine cuts the ſward in the ſame direction with the plough; and is liable, from every obſtruction any of the coulters meet with, to be thrown out of its work altogether, or the inſtrument broken; to which the ſward-cutter, conſiſting of four, ſix, or more cutting wheels, is never liable, from theſe being entirely independent of one another, cutting the ground acroſs the ridges before ploughing, and rendering that operation eaſier to two horſes than it would be to three without its being cut. The furrow being cut acroſs, falls finely from the plough in ſquares of any ſize required, not under ſix inches, in place of long ſlips of tough ſward ſeldom and imperfectly broken by the four-coultered plough.

This inſtrument is very fit for preparing ground for burnbating, as it will ſave much hard labour.

It may be properly uſed in croſs-cutting clover of one or two years ſtanding, to prepare the ground for wheat, if the land is ſtiff and moiſt enough.

It may be applied to cutting and croſs-cutting paſture ground, intended to have manure of any kind put upon

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upon it to meliorate the graſs. In this it will far exceed the ſcarificator mentioned in one of Mr Young's tours; as that inſtrument is liable, as well as the four-coultered plough, to be thrown out of its work when meeting with a ſtone or other interruption. This the ſward-cutter is proof againſt, which is looked on as its greateſt excellence.

In preparing for barley, the ſward-cutter excels a roller of any kind in reducing the large hard clods in clay land, occaſioned by a ſudden drought, after its being ploughed too wet; and it is likewiſe very proper for reducing ſuch clay land when under a ſummer fallow. In this operation, the ſward-cutter is greatly to be preferred to the cutting-roller, likewiſe mentioned by Mr Young in one of his tours; for the wheels of the latter being all dependent one on another, when one is thrown out by a ſtone, three or four muſt ſhare the ſame fate. Beſides, the cutting-roller has but ſeven wheels in ſix feet; whereas the ſward-cutter has ſix in four feet three inches, at nine inches diſtant; and, if neceſſary, may have them ſo near as ſix inches.

After old graſs ground is cut acroſs with the ſward-cutter and ploughed, it has a very uncommon and worklike appearance, from each ſquare turned over by the plough being raiſed up an inch or two at the ſide laſt moved by the earthboard; ſo that the field, when finiſhed, is all prettily waved, and reſembles a piece of water when blown on by a gentle breeze. By this means a very great deal of the land's ſurface is expoſed to the froſt and other influences of the air, which cannot fail to have a good effect on it.

Two horſes are ſufficient for the draught of a double-horſe ſward-cutter, and one horſe for a ſingle-horſe one. One man manages the machine and drives the horſes. He begins his operation by firſt meaſuring off 20 or 30 paces from the machine, leſs or more as he inclines, and there fixes a pole. He then cuts the field croſs, as near at right angles with the ridges as he can. When the cutting wheels are paſt the laſt furrow about a yard or ſo, and the machine is upon the utmoſt ridge of the field on which it muſt turn, he muſt ſtop the horſes; then take hold of the lever I, fig. 1. and by pulling it to him he raiſes the cutting wheels out of the ground, which are kept ſo by the loop of the rope being put over the pin R, in the lever I, fig. 2. till the machine is turned and brought to its proper place, which is done by meaſuring off the ſame diſtance formerly done on the oppoſite ſide of the field. When the cutting wheels are exactly over the outmoſt furrow, then, on the horſes being ſtopped, the rope is ſlipt off the pin R, and the lever returned to its former place, as repreſented fig. 1. which allows the weights LL, &c. to force the cutting wheels into the ground again. He then goes on until the interval betwixt the firſt and ſecond ſtroke of the machine is all cut. In this manner the field is to be finiſhed, after which you may begin to plough when you pleaſe. (N. B. There muſt be a pole at each ſide of the field.) Plate IX.

It is of no conſequence whether the land to be ſward-cut is in crooked ridges or ſtraight, in flat ridges or in very high raiſed ones. Be the ſurface ever ſo uneven, the cutting wheels, being all independent of one another, are forced by their weights into every furrow or hollow.

One ſward-cutter will cut as much in one day as ſix ploughs will plough.

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The land may lie ſeveral months in winter after being ſward-cut, when there is no vegetation to make the cuts grow together again before it is ploughed; but the ſooner it is ploughed after cutting the better, that it may have the benefit of all the winter's froſt, which makes it harrow better at ſeed time.

When the ground is harrowed, the harrows ought to go with the waves which appear after ploughing, not againſt them, as by that means they are leſs apt to tear up the furrows all cut into ſquares. This, however, need only be attended to the two firſt times of harrowing, as they are called.

Any common wright and ſmith may make the inſtrument. It is very ſtrong, very ſimple, and eaſily managed and moved from place to place; and, if put under cover, will laſt many years.

It was invented ſome time ago by the Honourable Robert Sandilands; and is repreſented in the plate as it has been lately improved by him, the price being at the ſame time reduced from 15l. or 16. to 5l. or 6l.

3. *The Cultivator.*

This inſtrument was invented by Mr William Leſter of Northampton; and that gentleman received, from the Society for the encouragement of Arts, the Society's ſilver medal. The purpoſe of this inſtrument is to pulverize tenacious ſoils that have been once ploughed, in a much more complete and rapid manner than can be accompliſhed by any other inſtrument. It is thus deſcribed, Plate XIII. fig. 3.—A, the beam; BB, the handles; CC, a croſs bar of a ſemicircular form con-

The cultivator deſcribed.

taining

Inſtruments of Huſbandry. taining a number of holes, which allow the two bars DD to be placed nearer or further from each other.

DD are two ſtrong bars moveable at one end upon a pivot E, and extending from thence in a triangular form to the croſs bar C. In theſe bars are ſquare holes, which allow the ſhares F placed therein to be fixed to any height required.

The ſeven ſhares marked F, are ſhaped at their lower extremities like ſmall trowels; the upper parts of them are ſquare iron bars.

GGG are three iron wheels on which the machine is moved; they may be raiſed or lowered at pleaſure.

H, the iron hook to which the ſwingle-tree and horſes are to be fixed.

When the machine is firſt employed on the land, the bars DD are expanded as much as poſſible. As the ſoil is more looſened, they are brought nearer to the centre; the ſhares then occupy a leſs ſpace, and the ſoil will conſequently be better pulverized.

In working on a rough fallow, therefore, the cultivator ſhould be ſet for its greateſt expanſion, and contracted in proportion as the clods are reduced. The inventor declares himſelf confident that one man, a boy, and ſix horſes, will move as much land in a day, and as effectually, as ſix ploughs, meaning land in a fallow ſtate that has been previouſly ploughed. It is requiſite in ſome ſtates of the ſoil to alter the breadth of the ſhares, but of this it is preſumed that every farmer will be a proper judge. By the expanſion and contraction of the cultivator, the points of the ſhares are in a ſmall degree moved out of the direct line; but this is ſaid to be ſo trifling as to prove no impediment to its working.

A certificate from Mr William Shaw of Cottenend, near Northampton, ſtates, that he had uſed Mr Leſter's cultivator, upon a turnip fallow in ſummer 1800; and that he believes it to be a very uſeful implement for cultivating the land in a fallow ſtate by its working or ſcuffling off ſeven acres per day with ſix horſes. He adds, that from its property of contracting and expanding, it is calculated to work the ſame land in a rough or fine ſtate, by which means it unites the principles of two implements in one, and by the index on the axis it may be worked at any depth if required.

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4. *The Brake.*

Brake deſcribed, Plate III. fig. 2.

The brake is a large and weighty harrow, the purpoſe of which is to reduce a ſtubborn ſoil, where an ordinary harrow makes little impreſſion. It conſiſts of four ſquare bulls, each ſide five inches, and ſix feet and a half in length. The teeth are 17 inches long, bending forward like a coulter. Four of them are inſerted into each bull, fixed above with a ſcrew-nut, having 12 inches free below, with a heel cloſe to the under part of the bull, to prevent it from being puſhed back by ſtones. The nut above makes it eaſy to be taken out for ſharping. This brake requires four horſes or four oxen. One of a leſſer ſize will not fully anſwer the purpoſe: one of a larger ſize will require ſix oxen; in which caſe the work may be performed at leſs expence with the plough.

Uſe.

This inſtrument may be applied to great advantage in the following circumſtances. In the fallowing ſtrong clay that requires frequent ploughings, a braking between every ploughing will pulverize the ſoil, and render the ſubſequent ploughings more eaſy. In the month of March or April, when ſtrong ground is ploughed for barley, eſpecially if bound with couch-graſs, a croſs-braking is preferable to a croſs-ploughing, and is done at half the expence. When ground is ploughed from the ſtate of nature, and after a competent time is croſs-ploughed, the brake is applied with great ſucceſs, immediately after the croſs-ploughing, to reduce the whole to proper tilth.

Let it be obſerved, that a brake with a greater number of teeth than above mentioned, is improper for ground that is bound together by the roots of plants, which is always the caſe of ground new broken up from its natural ſtate. The brake is ſoon choked, and can do no execution till freed from the earth it holds. A leſs number of teeth would be deficient in pulverizing the ſoil.

4. *The Harrow.*

Harrows are too frequently conſidered as of no uſe but to cover the ſeed; but they have another uſe ſcarce leſs eſſential, which is, to prepare land for the ſeed. This is an article of importance for producing a good crop. But how imperfectly either of theſe purpoſes is performed by the common harrow, will appear from the following account of it.

Imperfection of the common harrow.

The harrow commonly uſed is of different forms. The firſt we ſhall mention has two bulls, four feet long and 18 inches aſunder, with four wooden teeth in each. A ſecond has three bulls, and 12 wooden teeth. A third has four bulls and 20 teeth of wood or iron, 10, 11, or 12 inches aſunder. Now, in fine mould, the laſt may be ſufficient for covering the ſeed; but none of them are ſufficient to prepare for the ſeed any ground that requires ſubduing. The only tolerable

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ſorm is that with iron teeth; and the bare deſcription of its imperfections will ſhow the neceſſity of a more perfect form. In the firſt place, this harrow is by far too light for ground new taken up from the ſtate of nature, for clays hardened with ſpring drought, or for other ſtubborn ſoils: it floats on the ſurface; and after frequent returns in the ſame track, nothing is done effectually. In the next place, the teeth are too thick ſet, by which the harrow is apt to be choked, eſpecially where the earth is bound with roots, which is commonly the caſe. At the ſame time, the lightneſs and number of teeth keep the harrow upon the ſurface, and prevent one of its capital purpoſes, that of dividing the ſoil: nor will fewer teeth anſwer for covering the ſeed properly. In the third place, the teeth are too ſhort for reducing a coarſe ſoil to proper tilth; and yet it would be in vain to make them longer, becauſe the harrow is too light for going deep into the ground. Further, the common harrows are ſo ill conſtructed, as to ride at every turn one upon another. Much time is loſt in diſengaging them. Laſtly, It is equally unfit for extirpating weeds. The ground is frequently ſo bound with couch-graſs, as to make the furrow-ſlice ſtand upright, as when old ley is ploughed: notwithſtanding much labour, the graſs roots keep the field, and gain the victory.

A little reflection, even without experience, will make it evident, that the ſame harrows, whatever be the form, can never anſwer all the different purpoſes of harrowing, nor can operate equally in all different ſoils, rough or ſmooth, firm or looſe. The following, therefore, have been recommended; which are of three different forms, adapted for different purpoſes. They

Improved harrows. Plate IV. fig. 1.

are all of the ſame weight, drawn each by two horſes. Birch is the beſt wood for them, becauſe it is cheap, and not apt to ſplit. The firſt is compoſed of four bulls, each four feet ten inches long, three inches and a quarter broad and three and a half deep; the interval between the bulls 11 inches and three fourths; ſo that the breadth of the whole harrow is four feet, The bulls are connected by four ſheths, which go through each bull, and are fixed by timber nails driven through both. In each bull five teeth are inſerted, ten inches free under the bull, and ten inches aſunder. They are of the ſame form with thoſe of the brake, and inſerted into the wood in the ſame manner. Each of theſe teeth is three pounds weight: and where the harrow is made of birch, the weight of the whole is ſix *ſtone 14 pounds, Dutch. An erect bridle is fixed at a corner of the harrow, three inches high,* with four notches for drawing higher or lower. To this bridle a double tree is fixed for two horſes drawing abreaſt, as in a plough. And to ſtrengthen the harrow, a flat rod of iron is nailed upon the harrow from corner to corner in the line of the draught.

Fig. 2.

The ſecond harrow conſiſts of two parts, connected together by a crank or hinge in the middle, and two chains of equal length, one at each end, which keep the two parts always parallel, and at the ſame diſtance from each other. The crank is ſo contrived, as to allow the two parts to ply to the ground like two unconnected harrows; but neither of them to riſe above the other, more than if they were a ſingle harrow without a joint. In a word; they may form an angle downward, but not upward. Thus they have the effect of two harrows in curved ground, and of one weighty harrow in a plain. This harrow is compoſed of ſix bulls, each four feet long, three inches broad, and three and a half deep. The interval between the bulls nine inches and a half; which makes the breadth of the whole harrow, including the length of the crank, to be five feet five inches. Each bull has five teeth, nine inches free under the wood, and ten inches aſunder. The weight of each tooth is two pounds; the reſt as in the former.

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The third conſiſts alſo of two parts, connected together like that laſt mentioned. It has eight bulls, each four feet long, two inches and a half broad, and three deep. The interval between the bulls is eight inches; and the breadth of the whole harrow, including the length of the crank, is ſix feet four inches. In each bull are inſerted five teeth, ſeven inches free under the wood, and ten inches and a half aſunder, each tooth weighing one pound. The reſt as in the two former harrows.

Fig. 3.

Theſe harrows are a conſiderable improvement. They ply to curved ground like two unconnected harrows; and when drawn in one plane, they are in effect one harrow of double weight, which makes the teeth pierce deep into the ground. The imperfection of common harrows, mentioned above, will ſuggeſt the advantages of the ſet of harrows here recommended. The firſt is proper for harrowing land that has long lain after ploughing, as where oats are ſown on a winter furrow, and in general for harrowing ſtiff land: it pierces deep into the ſoil by its long teeth, and divides it minutely. The ſecond is intended for covering the ſeed: its long teeth lays the ſeed deeper than the common harrow can do; which is no ſlight advantage. By placing the ſeed

Properties of theſe harrows.

Inſtruments of Huſbandry. conſiderably under the ſurface, the young plants are, on the one hand, *protected from too much heat*, and, on the other, have ſufficiency of moiſture. At the ſame time, the feed is ſo well covered that none of it is loſt. Seed ſlightly covered by the common harrows wants moiſture, and is burnt up by the ſun; beſide, that a proportion of it is left upon the ſurface uncovered. The third harrow ſupplies what may be deficient in the ſecond, by ſmoothing the ſurface, and covering the ſeed more accurately. The three harrows make the ground finer and finer, as heckles do lint; or, to uſe a different compariſon, the firſt harrow makes the bed, the ſecond lays the ſeed in it, the third ſmooths the clothes. They have another advantage not inferior to any mentioned: they mix manure with the ſoil more intimately than can be done by common harrows; and upon ſuch intimate mixture depends greatly the effect of manure, as has already been explained. To conclude, theſe harrows are contrived to anſwer an eſtabliſhed principle in agriculture, That fertility depends greatly on pulverizing the ſoil, and on an intimate mixture of manure with it, whether dung, lime, marl, or any other.

Plate IV. The *Chain and Screw Harrow*. Fig. 6. is the plan of a harrow invented by Mr Sandilands, and to which he has given the name of the *chain and ſcrew harrow*. Its properties are, that if your ridges be high, and you wiſh to harrow them from one end to the other, by lengthening the chain (which the ſcrew commands), the harrow, when drawn along, forms an angle downwards, and miſſes none of the curve of the ridge, ſo far as it extends (which may be nine feet, the diſtance from A to B. The extent, in the contrary direction,

rection, is five feet ſix inches). When the crowns of the ridges have got what is thought a ſufficient harrowing lengthwiſe, you ſhorten the chain by the ſcrew, which forms an angle upwards; the harrow is then drawn by the horſes, one on each ſide of the furrow; which completely harrows it, and the ſide of the ridges, if 18 feet broad.

When you want to harrow even ground or high ridges acroſs with the ſcrew, you can bring the harrow to be horizontal, ſo as to work as a ſolid harrow without a joint.

The teeth are formed and fixed in the common manner, ſquare, not in the faſhion of coulters; and are nine or ten inches below the wood, and of ſuch ſtrength as it is thought the land requires. The teeth cut, or rather tear, the ground at every four inches without variation, though ſeemingly placed irregularly; and this without any riſk of choking, except ſometimes at the extreme angles, where the teeth are neceſſarily near each other; but which may be cleaned with the greateſt eaſe, by raiſing them a little from the ground. The figures 1, 2, &c. point out where the 12 teeth on each ſide of the harrow are placed.

Where a ſtrong brake-harrow is not neceſſary, by making the teeth ſhorter and lighter you may have 48 teeth, which will tear the ground at every two inches, cover the ſeed well, and make a fine mould.

It is recommended, that harrows for every purpoſe, and of any ſize, be made on the above principle; by which no tooth can ever follow the track of another, and all of them will be kept conſtantly acting.

5. *The Roller.*

The roller. The roller is an inſtrument of capital uſe in huſbandry, though, till of late years, ſcarcely known in ordinary practice; and where introduced, it is commonly ſo ſlight as to have very little effect.

Rollers are of different kinds; ſtone, caſt-iron, wood. Each of theſe has its advantages. We would recommend the laſt, conſtructed in the following manner: Take the body of a tree, ſix feet ten inches long, the larger the better, made as near a perfect cylinder as poſſible. Surround this cylinder with three rows of fillies, one row in the middle, and one at each end. Line theſe fillies with planks of wood equally long with the roller, and ſo narrow as to ply into a circle. Bind them faſt together with iron rings. Beech wood is the beſt, being hard and tough. The roller, thus mounted, ought to have a diameter of three feet ten inches. It has a double pair of ſhafts for two horſes abreaſt. Theſe are ſufficient in level ground; in ground not level, four horſes may be neceſſary. The roller without the ſhafts ought to weigh 200 ſtone Dutch; and the large diameter makes this great weight eaſy to be drawn.

Seaſon for rolling. Rolling wheat in the month of April is an important article in looſe ſoil; as the winter rains preſſing down the ſoil leave many roots in the air. Barley ought to be rolled immediately after the ſeed is ſown; eſpecially where graſs ſeeds are ſown with it. The beſt time for rolling a gravelly ſoil, is as ſoon as the mould is ſo dry as to bear the roller without clinging to it. A clay ſoil ought neither to be tilled, harrowed, nor rolled, till the field be perfectly dry. And as rolling

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ing a clay ſoil is chiefly intended for ſmoothing the ſurface, a dry ſeaſon may be patiently waited for, even till the crop be three inches high. There is the greater reaſon for this precaution, becauſe much rain immediately after rolling is apt to cake the ſurface when drought follows. Oats in a light ſoil may be rolled immediately after the ſeed is ſown, unleſs the ground be ſo wet as to cling to the roller. In a clay ſoil, delay rolling till the grain be above ground. The proper time for ſowing graſs ſeeds in an oat field, is when the grain is three inches high; and rolling ſhould immediately ſucceed, whatever the ſoil be. Flax ought to be rolled immediately after ſowing. This ſhould never be neglected; for it makes the ſeed puſh equally, and prevents after-growth; the bad effect of which is viſible in every ſtep of the proceſs for dreſſing flax. The firſt year's crop of ſown graſſes ought to be rolled as early the next ſpring as the ground will bear the horſes. It fixes all the roots preciſely as in the caſe of wheat. Rolling the ſecond and third crops in looſe ſoil is an uſeful work; though not ſo eſſential as rolling the firſt crop.

Effects of rolling.

In the firſt place, rolling renders a looſe ſoil more compact and ſolid; which encourages the growth of plants, by making the earth adhere cloſe to every part of every root. Nor need we be afraid of rendering the ſoil too compact; for no roller that can be drawn by two or four horſes will have that effect. In the next place, rolling keeps in the moiſture, and hinders drought to penetrate. This effect is of great moment. In a dry ſeaſon, it may make the difference of a good crop, or no crop, eſpecially where the ſoil is light. In the third place, the rolling graſs ſeeds, beſide the foregoing advantages, facilitates the mowing for hay; and it is to be hoped, that the advantage of this practice will lead farmers to mow their corn alſo, which will increaſe the quantity of ſtraw both for food and for the dunghill.

There is a ſmall roller for breaking clods in land intended for barley. The common way is, to break clods with a mallet; which requires many hands, and is a laborious work. This roller performs the work more effectually, and at much leſs expence. Let a harrowing precede, which will break the clods a little; and after lying a day, or a day and a half, to dry, this roller will diſſolve them into powder. This however does not ſuperſede the uſe of the great roller after all the other articles are finiſhed, in order to make the ſoil compact; and to keep out the ſummer drought. A ſtone roller four feet long, and fifteen inches diameter, drawn by one horſe, is ſufficient to break clods that are eaſily diſſolved by preſſure. The uſe of this roller in preparing land for barley is gaining ground daily, even among ordinary tenants, who have become ſenſible both of the expence and toil of uſing wooden mells. But in a clay ſoil, the clods are ſometimes too firm, or too tough, to be ſubdued by ſo light a machine. In that caſe, a roller of the ſame ſize, but of a different conſtruction, is neceſſary. It ought to be ſurrounded with circles of iron, ſix inches aſunder, and ſeven inches deep; which will cut even the moſt ſtubborn clods, and reduce them to powder. Let not this inſtrument be conſidered as a finical refinement. In a ſtiff clay it may make the difference of a plentiful or ſcanty crop.

6. *The*

6. *The Fallow-cleanſing Machine.*

The fallow- cleanſing achine. late VI. ig. 1.

This was invented by Mr Aaron Ogden, a ſmith at Aſhton-under-Line, near Mancheſter in Lancaſhire. It is intended for cleanſing fallows from weeds, &c. which exhauſt the riches of the ſoil. A, A, is the frame; B, the firſt roller; C, the ſecond ditto; in which laſt are two cranks to move the arms D, D, which work the rake up the directors fixed on the plank E. The under ſide of the lower ends or ſhares of theſe directions are ſharp, to cut the clods and let them come on the upper ſide. Each alternate heel of the ſhare is longer than the intermediate one, that they may not have more than one-half to cut at once. At the back of the plank E are two ſcrews to let it looſe, that the directors may be ſet higher or lower. The ſhares are to penetrate the ground two or three inches, to raiſe the quicks till the rake I, I, fetches them into the cart H, where a man muſt be ready with a muck-hook to clear them backward when gathered. In the rake I are two teeth for every ſpace of the directors, that ſtones, &c. may be gathered without damage. K, K, are two ſtaples, by which the machine is drawn: under them at *h* are two hooks, placed low to raiſe the machine in turning, by the help of the traces; and the axle-tree of the cart ſhould be fixed upon a pin, that it may turn like a waggon. F, F, are the triggers to throw the rake behind the roots. The long teeth at G, G, are to cleanſe the roller C. I, I, is the rake which gathers up the weeds into the cart H, and is drawn above the trigger F by the working of the arms D, expreſſed by the dotted lines at *d d*, *i i i*. The triggers F, of which there is one on each ſide, move on the pivots *a*; ſo that when the points *b* of the rake I have been drawn up by the directors E to the part marked *c*, the trigger, giving way, permits the rake to paſs; but immediately falling, the rake returns along the upper ſurface of the trigger marked *e*, *e*, and of courſe falls on the weeds when it comes to the end, a little beyond the pivot *a*. The reader will obſerve, that the boarding is taken away on one ſide, in the Plate, in order to give a more perfect view of the inner parts of the machine; and in fact it would perhaps be better if all the boarding, marked L, L, L, was taken away, and frame-work put in its ſtead. The cart H might undoubtedly alſo be made lighter. The wheels M, M, appear in the Plate to be made of ſolid wood: but there is no neceſſity they ſhould be ſo. At N, is another view of the roller C, by which the diſpoſition of the ſpikes may be eaſily comprehended. Suppoſe the circle O, deſcribed by the end of the roller N, to be divided by four ſtraight lines into eight equal ſegments, as repreſented at P. Let the ſame be done at the other end of the roller, and parallel lines be drawn from one correſponding point to the other the length of the roller; mark the points with figures 1, 2, 3, 4, 5, 6, 7, 8; afterwards draw oblique lines, as from 1, at the end of O, to 2, at the other end, and from 2 to 3, &c.: on theſe oblique lines the ſpikes are to be fixed at equal diſtances, in eight circles, deſcribed on the circumference of the roller. The ſpikes of the ſmall roller B are fixed in the ſame manner, except that the diameter being ſmaller, there are only ſix inſtead of eight rows. R is another view of the directors, with the plank E on which they are fixed; and S is a ſection of a part of the plank, with one of the directors as fixed, in which

Plate VI. fig. 2.

Fig. 3.

Fig. 5.

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Fig. 3.

which may be ſeen the heel *m*, from whence to the point of the ſhare *n* is a ſharp cutting edge. See the ſame letters in figure R. At T is one of the long teeth to be ſeen at G; it is bent towards the roller C, which it ſerves to cleanſe. When the end of the rake *b*, after riſing above *c*, is puſhed, by the motion of the arms D, D, along the upper part *e*, *e*, of the trigger F, and comes to the end beyond *a*; as it falls, the part of the arm marked *o* reſts on the notch *p*, till it is again raiſed by the motion of the roller C with the rake. The roller C is to be one foot diameter, the ſpikes nine inches long, that they may go through the furrow (if the ſoil ſhould be looſe) into the hard earth, the more effectually to work the rake, which otherwiſe might be ſo overcharged as to cauſe the roller to drag without turning. In the rake-ends *b* there ſhould be pivots, with rollers or pullers on, to go in the groove, to take off the friction; and they would likewiſe take the triggers more ſurely as the rake comes back. The rake ſhould alſo be hung ſo far backward, that when it is fallen the arms of it may lie in the ſame plane or parallel with the directors, on which it comes up (which will require the frame to be two inches longer in the model). This will cauſe the rake to fall heavier, and drive the teeth into the roots, and bring them up without ſhattering. Theſe teeth muſt be made of ſteel, very fine, and ſo long as to reach down to the plank on which the directors are fixed, that is to ſay, ſix inches long (the directors are alſo to be made ſix inches broad above the plank). The rake-head ſhould alſo fall a little before the crank is at its extremity, which will cauſe the rake to puſh forward to let the teeth come into the roots. The rake-teeth

muſt

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muſt drop in the ſame plane with the roller and wheels, or on the ſurface of the earth. No more ſpace ſhould be given from the roller C to the long teeth at G G than that the rake may juſt miſs the ſpikes of the roller C and fall on the places before mentioned. As the firſt roller B was intended to cleanſe the ſecond C more than for any other uſe, it may be omitted when the machine is made in large, as Mr Ogden has lately found that the long teeth at GG anſwer the end alone, and this renders the machine about a ſixth part ſhorter. Now, to ſuit any ſort of earth, there ſhould be to each machine three planks, with directors at different ſpaces to uſe occaſionally: in the firſt, the ſpaces between the directors ſhould be eight inches wide, in the ſecond ſix, and in the third four. This will anſwer the ſame end as having ſo many machines.

As there may be ſome objections to the rake not leaving the roots when it has brought them up, Mr Ogden has ſeveral methods of cleanſing it; but as he would make it as ſimple as poſſible, he chooſes to let it be without them at preſent; but ſuppoſe it ſhould bring ſome roots back again with it, it will probably loſe them before it gets back to the extremity; whence they will lie light, and be of but little detriment to the others coming up. Mr Ogden would have the firſt machine made four feet ſix inches wide, the teeth divided into equal ſpaces, the outſides into half ſpaces.

7. *The new-invented Patent Univerſal Sowing Machine.*

Univerſal ſowing machine. Plate VII. fig. 2. 3. and Plate VIII. fig. 9.

This machine, whether made to be worked by hand, drawn by a horſe, or fixed to a plough, and uſed with it, is extremely ſimple in the conſtruction, and not liable to be put out of order; as there is but one movement

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movement to direct the whole, nor does it require any ſkill in working. It will ſow wheat, barley, oats, rye, clover, cole-ſeed, hemp, flax, canary, rape, turnip, beſides a great variety of other kinds of grain and ſeeds broad-caſt, with an accuracy hitherto unknown. It is equally uſeful in the new huſbandry, particularly when fixed to a plough; it will then drill a more extenſive variety of grain, pulſe, and ſeed (through every gradation, with regard to quantity), and deliver each kind with greater regularity than any drill-plough whatever. When uſed in this manner, it will likewiſe be found of the utmoſt ſervice to farmers who are partial to the old huſbandry, as, among many other very valuable and peculiar properties, it will not only ſow in the broad-caſt way with the moſt ſingular exactneſs, but ſave the expence of a ſeedſman; the ſeed being ſown (either over or under furrow at pleaſure), and the land ploughed, at the ſame operation.

Perhaps a fair and deciſive experiment for aſcertaining the ſuperior advantage of broad-caſting or drilling any particular crop, was never before ſo practicable; as the ſeed may now be put in with the utmoſt degree of regularity, in both methods of culture, by the ſame machine; conſequently, the ſeed will be ſown in both caſes with equal accuracy, without which it is impoſſible to make a juſt deciſion.

The excellence of this machine conſiſts in ſpreading any given quantity of ſeed over any given number of acres with a mathematical exactneſs, which cannot be done by hand; by which a great ſaving may be made in ſeeding the ground, as well as benefiting the expected crop.

There has always been a difficulty in ſowing turnip ſeed

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ſeed with any degree of exactneſs, both from the minuteneſs of the ſeed, and the ſmallneſs of the quantity required to be ſown on an acre. Here the machine has a manifeſt advantage, as it may be ſet to ſow the leaſt quantity ever required on an acre; and with an accuracy the beſt ſeedſman can never attain to.

It will alſo ſow clover, cole, flax, and every other kind of ſmall ſeed, with the utmoſt degree of regularity.

It will likewiſe broad-caſt beans, peaſe, and tares, or drill, them with the greateſt exactneſs, particularly when conſtructed to be uſed with a plough.

Another advantage attending the uſe of this machine is, that the wind can have no effect on the falling of the ſeed.

Of the Machine when made to be uſed without a Plough, and to be drawn by a Horſe.—It may in this caſe be made of different lengths at the deſire of the purchaſer. The upper part AAAA, contains the hoppers from which the grain or ſeed deſcends into the ſpouts. The ſeveral ſpouts all reſt upon a bar, which hangs and plays freely by two diagonal ſupports BB; a trigger fixed to this bar bears a catch-wheel; this being fixed on the axle, occaſions a regular and continual motion, or jogging of the ſpouts, quicker or ſlower in proportion to the pace the perſon ſowing with it drives; and of courſe, if he quickens his pace, the bar will receive a greater number of ſtrokes from the catch-wheel, and the grain or ſeed will feed the faſter. If he drives ſlower, by receiving fewer ſtrokes, the contrary muſt take place. In going along the ſide of a hill, the ſtrength of the ſtroke is corrected by a ſpring which acts with more or leſs power, in proportion as the machine is

Plate VII. fig. 2.

more or leſs from the horizontal poſition, and counteracts the difference of gravity in the bar, ſo that it preſſes, in all ſituations, with a proper force againſt the catch-wheel. This ſpring is unneceſſary if the land be pretty level. At the bottom of the machine is placed an apron or ſhelf in a ſloping poſition; and the corn or ſeed, by falling thereon from the ſpouts above, is ſcattered about in every direction under the machine, and covers the ground in a moſt regular and uniform manner.

To ſow the corn or ſeed in drills, there are moveable ſpouts (ſee fig. 8.), which are fixed on or taken off at pleaſure, to direct the ſeed from the upper ſpout to the bottom of the furrow. Plate VIII.

The machine is regulated for ſowing any particular quantity of ſeed on an acre by a braſs ſlider, A, fig. 7. fixed by ſcrews againſt a braſs bridge on each of the ſpouts. The machine is prevented from feeding while turning at the ends, by only removing the lever E, fig. 3. out of the channel G, to another at H, on the right hand of it, which carries back the bar from the catch-wheel, and occaſions the motion of the ſpouts to ceaſe, and at the ſame time brings them upon a level by the action of the diagonal ſupporters; ſo that no corn or ſeed can fall from them. Plate VII.

The machine in this form is particularly uſeful for broad-caſting clover upon barley or wheat; or for ſowing any other kind of ſeed, where it is neceſſary that the land ſhould firſt be harrowed exceedingly fine and even.

Manner of uſing the Machine, when drawn by a Horſe.—Place the machine about two feet from the ends of the furrows where you intend it ſhall begin to ſow.

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Plate VII.

ſow. Fill the hoppers with ſeed, and drive it forwards with the outſide wheel in the firſt furrow. When you are at the end of the length, at the oppoſite ſide of the field, lift the lever E, fig. 3. into the channel H, and the machine will inſtantly ſtop ſowing. Drive it on about two feet, and then turn. Fill the hoppers again if neceſſary; then remove the lever back again into the channel G, and in returning, let the outſide wheel of the machine go one furrow within the track which was made by it, in paſſing from the oppoſite end; as for example, if the wheel paſſed down the eighth furrow from the outſide of the field, let it return in the ſeventh; and in every following length let the outſide wheel always run one furrow within the track made by the ſame wheel: becauſe the breadth ſown is about nine inches leſs than the diſtance between the wheels.

Let the machine be kept in a perpendicular ſituation. If the farmer wiſhes to ſow more or leſs ſeed on any one part of the field than the other, it is only raiſing the handles a little higher, or ſinking them a little lower than uſual, and it will occaſion a ſufficient alteration; and ſhould the laſt turn be leſs in breadth than the machine, thoſe ſpouts which are not wanted may be taken up from the bar, and prevented from feeding, by turning the knob above them.

Alſo, when the land required to be ſown has what is called a *vent*, that is, when the ſides of the field run in an oblique line to the furrows, which by this means are unequal in length; the ſpouts muſt be taken up or let down in ſucceſſion by turning the knobs, as that part of the machine where they are placed arrives at the ends of the furrows. This is done while the machine is going forwards.

If the land be tolerably level, the machine may be fixed by the ſcrew in the front, and the machine may then be uſed by any common harrow boy.

Method of regulating the Machine.—In each ſpout is fixed a bridge (ſee fig. 5. Plate VII.), with an aperture in it, B, for the grain or ſeed to paſs through. This aperture is enlarged or contracted by a ſlider, A, which paſſes over it; and, when properly fixed for the quantity of ſeed deſigned to be ſown on an acre, is faſtened by means of two ſtrong ſcrews firmly againſt the bridge. This is made uſe of in ſowing all kinds of ſeed, where it is required to ſow from one buſhel upwards on an acre. To ſow one, two, three gallons, or any of the intermediate quantities, as of clover, cole-ſeed, &c. the braſs plate, fig. 4. is placed between the bridge and the ſlider, with the largeſt aperture B downwards, which aperture is enlarged or contracted by the ſlider as before. To ſow turnips, the ſame plate is placed between the bridge and the ſlider, with its ſmalleſt aperture A downwards, and the hollow part about the ſame aperture inwards.

Plate VIII.

Fig. 6. is a view of the regulator, by which the apertures in the ſeveral ſpouts are all ſet exactly alike, with the utmoſt eaſe, to make them feed equally. The extreme height of the largeſt aperture is equal to the breadth AB, and the breadth at C is equal to the height of the ſmalleſt aperture uſed, viz. that for turnips. The ſide AC is divided into 60 equal parts, and on it moves the ſlider or horſe D; which being placed at any particular degree, according to the quantity of ſeed required to be ſown on an acre, is fixed upon it, by a ſcrew on the ſide of the ſlider or horſe. When this is done, the end of the regulator is put

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through the aperture in the bridge or plate (whichever is intended to be uſed), and the ſlider againſt the bridge in the ſpout, raiſed by it, till it ſtops againſt the horſe on the regulator: then the ſlider is faſtened againſt the bridge firmly by the two ſcrews; care being taken at the ſame time that it ſtand nearly ſquare.

By this means the ſpouts (being all fixed in the ſame manner) will feed equally.

It is eaſy to conceive that the ſize of the apertures, and conſequently the quantity of ſeed to be ſown on an acre, may be regulated with a far greater accuracy than is required in common practice.

The ſpouts may be regulated with the utmoſt nicety, in five minutes, to ſow each particular ſeed, for the whole ſeaſon. But a little practice will enable any perſon, who poſſeſſes but a very moderate capacity, to make the ſpouts feed equally, even without uſing the regulator *.

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* Proper directions are given with each machine for uſing it, as alſo for fixing the ſliders to ſow any particular quantity of corn or ſeed on an acre, ſo as to enable any perſon to ſet the ſpouts.

The prices of the machine (excluſive of the packing caſes) are as follow. If conſtructed to be uſed with a ſingle-furrow plough; the wheel, with the axle and cheeks ſteeled, ſtrap, regulator, braſs-plates for broad-caſting or drilling turnips, lucerne, tares, wheat, barley, &c. and every article neceſſary for fixing it included, three guineas and a half. If made with a ſpring (for ſowing on the ſide of a hill, where the ſlope is conſiderable), but which is very rarely neceſſary, five ſhillings more. If made to be fixed to any double-furrow plough, four guineas and a half.

The large machine, fig. 3. Plate VII. when made to broad-caſt ſeven furrows at a time and to be drawn by a horſe, eight guineas and a half. If conſtructed to ſow five furrows at a time, and to be uſed by hand, ſix guineas. Theſe are alſo five ſhillings more if made with a ſpring.

Of the Machine, when made to be uſed by Hand.—The difference of the machine in this caſe is, that it is made lighter, with but three ſpouts, without ſhafts, and is driven forwards by the handles. It hath alſo a bolt in front, which being puſhed in by the thumb, releaſes the machine; ſo that it can then eaſily be placed in a perpendicular poſition. This alteration is neceſſary to keep the handles of a convenient height, in ſowing up and down a hill, where the ſlope is conſiderable; and is done while the machine is turning at the end of the length. The method of regulating and uſing it is the ſame as when made to be drawn by a horſe.

Of the Machine, when conſtructed to be uſed with a Plough.—This is, without doubt, the moſt uſeful application of the machine; and it can be fixed without difficulty to any kind of plough, in the ſame manner as to that repreſented in fig. 2. Plate VII.

The advantages ariſing from the uſe of it are great and numerous; for, beſide the increaſe in the crop, which will be enſured by the ſeeds being broad-caſt with a mathematical nicety, a large proportion of ſeed (the value of which alone, in a few months, will amount to more than the price of the machine) and the ſeedsman's labour will be ſaved. The ſeed may likewiſe be ſown either under or over furrow; or one caſt each way, as is practiſed by ſome farmers. The ſeeds alſo, being caſt by the machine upon the freſh ploughed land, may be immediately harrowed in, before the mould has loſt any part of its moiſture; which in a dry ſeaſon will greatly promote the crop. In drilling any kind of grain, pulſe, or ſeed, it poſſeſſes every property that can be wiſhed for in the beſt drill-plough, nor will it (as moſt of them do) bruiſe the ſeed, or feed irregularly.

gularly. The conſtruction of the machine is the ſame as the large ones, except being made with one hopper and ſpout inſtead of ſeveral, and the apron moveable inſtead of being fixed, as may be ſeen by inſpecting fig. 1. Plate VIII. The only alteration neceſſary to make the machine broad-caſt or drill is, in the former caſe to place the apron B, fig. 2. Plate VII. at the bottom of the machine, upon the hooks FF, ſloping either towards the furrows or the unploughed land, according as it is intended to ſow the ſeed, either over or under furrow. Whenever the apron is required to be ſhifted, it is done in leſs than a ſecond of time; as it only requires to be moved up or down with the hand, when a catch fixes it.

To prepare it for drilling, inſtead of the apron, place the long ſpout, fig. 8. Plate VIII. upon the brackets, on the front of the machine, by the ears AA, to receive the ſeed from the upper ſpout, and faſten the lower end of it, by a ſmall cord, to that hook upon which the apron is hung for broad-caſting which is next the plough (ſee fig. 1. Plate VIII.); the ſeed will then be directed by the long ſpout to the centre of the furrow, near the heel of the plough. The ſpring for correcting the ſtrength of the ſtroke, is neceſſary only when they are required to go along the ſide of a conſiderable declivity. The machine, when fixed to a plough, does not require the ſmalleſt degree of ſkill in uſing, as nothing is neceſſary but to keep the hopper filled, which will contain a ſufficient quantity of ſeed to go upwards of 140 rods, before it will want refilling, when three buſhels and a half are ſown on an acre. The accuracy with which it will broad-caſt, may in ſome meaſure be conceived, by conſidering that the ſeed regularly deſcends upon

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the apron or ſhelf, and is from thence ſcattered upon the ground, in quantity exactly proportioned to the ſpeed of the plough: alſo that each caſt ſpreads to the third furrow: and by this means ſhuts upon the laſt. In this manner it is continually filling up till the whole field is completely covered; ſo that it is impoſſible to leave the ſmalleſt ſpace without its proper quantity of ſeed.

When the plough is wanted for any other purpoſe, the machine, with the wheel at the heel of the plough for giving it motion, can be removed or replaced at any time in five minutes.

Plate VIII.

Fig. 9. repreſents the machine fixed to a double-furrow creaſing plough, and prepared for drilling. As this plough may not be generally known, it will not be improper to obſerve, that it is chiefly uſed for creaſing the land with furrows (after it has been once ploughed and harrowed); which method is neceſſary when the ſeed is to be ſown broad-caſt upon land that has been a clover ley, &c. becauſe, if the ſeed be thrown upon the rough furrows, a conſiderable part of it will fall between them, and be unavoidably loſt, by lying too deep buried in the earth. This mode anſwers extremely well, and partakes of both methods of culture; the ſeed, though ſown broad-caſt, falling chiefly into the furrows.

The machine is very uſeful for ſowing in this manner; as the ſeed is broad-caſt, with an inconceivable regularity, at the time the land is creaſed. The advantages it likewiſe poſſeſſes for drilling all ſorts of grain or ſeed with this plough, are too evident to need mentioning.

The machine, when conſtructed to be uſed with a double-furrow plough, is made with two upper and two long ſpouts for drilling, two aprons for broad-caſting, and with a double hopper; but in other reſpects the ſame as when intended for a ſingle-furrow plough: it is uſed in all caſes with the greateſt eaſe imaginable.

The interval between the points of the two ſhares of a creaſing plough is uſually ten inches; the beam about nine feet long; and the whole made of a light conſtruction.

Plate VII. *A more particular explanation of the figures.*—Fig. 2. The machine fixed to a Kentiſh turn wreſt plough. A, The machine. B, The apron upon which the ſeed falls and rebounds upon the land, in broad-caſting. C, Lid to cover the hopper. D, Wheel at the heel of the plough. E, Strap. FF, Hooks, upon which the apron turns by a pivot on each ſide. G, Stay, to keep the machine ſteady. H, Lever, to prevent it from ſowing.

Fig. 3. The machine conſtructed to be drawn by a horſe. AAAA, The hoppers. BB, The diagonal ſupporters. CCCC, The upper ſpouts. D, The apron or ſhelf upon which the ſeed falls from the upper ſpouts. E, The lever, which carries back the bar, and prevents the machine from ſowing. FF, Staples upon the handles, through which the reins paſs, for the man who conducts the machine, to direct the horſe by. I, Screw, to fix the machine occaſionally. N. B. The knobs (by turning which each particular ſpout may be taken from off the bar, and thereby prevented from feeding) are over each upper ſpout; but, to prevent confuſion, are not lettered in the Plate.

Plate VIII. Fig. 1. is the ſame machine with that in fig. 2. Plate VII.

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VII. The dotted lines, expreſſing the ſituation of the long ſpout, when the apron is removed, and the machine adapted for drilling.

Plate VIII.

Fig. 2. Alſo the ſame machine, with the front laid open to ſhow the inſide. A, The catch-wheel fixed upon the axle. BB, The axle upon which the machine hangs between the handles of the plough. C, The pulley, by which the ſtrap from the wheel at the heel of the plough turns the catch-wheel. D, the bar, upon which the upper ſpout reſts, ſuſpended by the diagonal ſupporters EE, bearing againſt the catch-wheel by the trigger F, and thereby kept in motion while the plough is going. G, The apron in a ſloping poſition, upon which the corn or ſeed falls from the upper ſpout, and is ſcattered by rebounding upon the land. It turns upon pivots, and by this means throws the ſeed either towards the right hand or left at pleaſure.

Fig. 3. The upper ſpout.

Fig. 4. The plate which is placed between the bridge and the ſlider, for ſowing ſmall ſeeds. The aperture A being downwards for ſowing turnips; the larger one B downwards for ſowing clover, &c.

Fig. 5. The bridge, fixed in the upper ſpouts. A, The ſlider, which contracts or enlarges the different apertures. B, The aperture in the bridge, through which the ſeed paſſes, when ſowing any quantity from one buſhel upwards on an acre.

Fig. 6. The regulator, made of braſs. D, The ſlider or horſe which moves upon it, and is fixed at any particular degree by a ſcrew in its ſide.

Fig. 7. repreſents the movement in the machine fig. 3. Plate VII. AAAA, Cleets, between which the upper ſpouts reſt. BB, The diagonal ſupporters, by which the bar with the upper ſpouts hang. C, The catch-wheel. DD, The axle. E, The trigger upon the bar, which bears againſt the catch-wheel. FF, Stays from the back of the machine, by which the bar plays.

late VIII. Fig. 8. The long ſpout. AA, The ears by which it hangs.

Of the Thraſhing Machine.

We have already mentioned, that from the remoteſt antiquity the practice prevailed and ſtill prevails in Aſia, of treading out the corn from the ear by means of the feet of cattle. In the United States of America, where human labour is very expenſive, the ſame mode of proceeding is ſtill adopted. It alſo exiſts in the ſouthern parts of Europe. Mr Young ſpeaks of it as practiſed in the province of Languedoc and other parts, in the following terms *.—“ *Languedoc.* Through all the ſouthern parts of this province they tread out the corn with horſes and mules; a man in the centre of the thraſhing-floor in the open air drives them round, and other men ſupply the floor and clear away the ſtraw. In ſome converſation I had on this method between Narbonne and Niſſan, I was aſſured it was far preferable to the uſe of flails; that 24 mules or horſes, and 12 men, would *depique*, as they term it, 150 ſeptiers of wheat in a day; that ſome farms produce 2000 ſeptiers of corn. What would flails do for ſuch a quantity! I examined the wheat, and did not find it more damaged than with flails; but the climate is to be remembered, which makes the grain much harder than any with us. Seeing ſome flails going alſo, I demanded the reaſon, and was told that the maſter would ſometimes have particular parcels of ſtraw thraſhed ſo, to get the corn that was left in it, if he ſuſpected too much; at others, the labourers deſire to do it for themſelves, which is ſometimes granted.

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* *Travels*, vol. ii.

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"*Provence.*—Seeing a large quantity of the preſident's wheat ſpread on cloths for drying in the ſun, and inquiring what it meant; I found it was waſhed, as all is, of which the beſt bread is made; owing, beyond all doubt, to the mode of threſhing, which renders it ſo foul, that this operation is neceſſary."

The ſoftneſs of the grain in our northern climates, together with the ſuperior cleanneſs of the operation, appears to have introduced at an early period, and to have rendered univerſal, the practice of ſeparating the grain from the chaff and ſtraw, by means of the flail, conſiſting of two ſticks looſely attached to each other at one end by a rope; the one being held in the hands, while with the other the ſheaves of corn are beaten with repeated ſtrokes. The laborious, tedious, and expenſive nature of this operation, long induced farmers to wiſh that ſome mode could be contrived by means of mechaniſm, to abridge the toil of beating out the grain by flails. Accordingly, we underſtand that various attempts were made by ingenious men to conſtruct a thraſhing machine.

In particular, about the middle of the late century, Mr Menzies (of Culterallers, we believe, in the upper part of Clydeſdale) conſtructed one which conſiſted of a number of flails moved by a water wheel. A Mr Stirling of Perthſhire, contrived and uſed another upon the principles of the flax mill. About the year 1773, a Mr Ilderton at Alnwick erected a machine which acted upon the principle of rubbing or preſſing out the corn. At the ſame time a Mr Oxley at Flodden framed one with ſkutchers, but of a defective nature, and poſſeſſing little * velocity. The late Sir Francis Kinloch of Gilmerton, Bart. brought to Scotland a model of Mr Ilderton's machine, which he ſent to be tried by means of the water-wheel of a barley mill, belonging to Mr Andrew Meikle, civil engineer at Houſton mill, near Haddington. It was torn to pieces in the trial, and when tried anew upon a larger ſcale, the ſame accident occurred. Mr Meikle himſelf, however, invented the new machine which is at preſent in uſe, and which is now known and employed not only in Britain, but alſo on the continent of Europe, and in America. We have learned with regret, that, like many other improvers of this moſt important of all arts, Mr Meikle has derived little or no emolument from his invention. The machine has received various improvements, or at leaſt, alterations: but the following is, we believe, upon the whole, one of the moſt approved forms of its conſtruction. N° 1. N° 2. and N° 3. are drawn to one-fourth of an inch to a foot, and N° 4. and N° 5. are drawn to one-half inch to a foot.

Plate XVI. N° 1. A, The conical wheel, commonly called the horſe-wheel, working into a caſt-iron pinion C, fixed on the axle D. On ſaid axle is hung or fixed a ſpur-wheel E, working into a caſt-iron pinion H, wedged on the drum ſpindle S, for driving the drum GGG. On the

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* *Farmer's Magazine*, June 1803.

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the other end of the drum ſpindle is fixed a ſmall conical pinion, ſix inches diameter, working two conical wheels, 12 inches diameter, O, fixed upon wrought iron ſpindles XX; on each end of ſpindles is fixed a pinion of ſix inches diameter, O, working a wheel of 12 inches diameter; the one fixed on the axle, for driving or moving the ſhaker F; the other end for driving the caſt-iron feeding rollers I. On the ſaid feeding roller are two ſmall ſpindles K, each with a ſquare ſocket going on the end of the ſpindles or gudgeons, fixed in the ſaid feeding rollers I. On the ſaid ſpindles K are fixed two ſmall pinions ZZ, of equal diameter, for turning of the upper roller I, being about four inches diameter. PP, The two top rails of drum and ſhaker framing, ſupported by the poſts *t t*, in N° 2. LLL, The beams for ſupporting the horſe-wheel axle B. Theſe beams are commonly ſupported from the barn wall, and ſtone pillars built for ſupporting the roof of horſe courſe. *m*, *m*, *m*, *m*, The four levers fixed round the upright axle B that the horſes are yoked to. *n*, *n*, *n*, *n*, *n*, *n*, The arms of the horſe-wheel A. In N° 2. Plate XVII. and N° 3. Plate XVIII. is a wheel R, for ſupporting the arms of horſe-wheel A, &c. S, Bolſter and framing for ſupporting the foot of upright ſhaft.

The ſaid reference for N° 1. deſcribes N° 2. and N° 3.

N° 4. exhibits the corn-bruiſers.

Plate XIX.

a, Caſt-iron fly-wheel fixed on the end of one of the rollers *d d*, wrought by a handle *b*. This machine is wrought with a handle, either from the fly or from the caſt-iron ſpur-wheel, C, working the pinions *c c* on the end of the rollers. The handles on the ſpur-wheel *k* may be taken off, and wrought eaſily with one man, Inſtruments of Huſbandry. from the handle on the fly, *b*. The hopper, *b*, is ſupported between the poſts *ff*, with a feeding board at the bottom, moved up and down with a pinion of four teeth fixed on the end of one of the rollers, for feeding and ſpreading the corn equally between the rollers, *d d*, where the corn paſſes through into a drawer or box *e*. The rollers *d d* are regulated by two iron ſcrews going through the two poſts *ff*, to anſwer the bruiſing of all kinds of grain.

Plate XIX. N° 5. is the ſtraw-cutter.

A, The fly wrought by the handle B. On the ſame axle the fly is on there is an endleſs face-wheel C, working two pinions DD. Theſe pinions are fixed on the end of two ſmall iron ſpindles, going through the wooden rollers covered with pierced iron, for feeding forward the ſtraw through the opening X, where the ſtraw or hay is cut by the three knives EEE, ſcrewed to the arms of the fly-wheel A. The iron frame F moves from the centre P, with a round eye on each end of the upper roller ſpindle, to move the upper roller up and down according to the thickneſs of the feed of the ſtraw or hay.

In addition to theſe, ſome other inſtruments are uſed in agriculture.

Of theſe we may mention the corn fan or *fanners*, which every farmer in Scotland and the north of England poſſeſſes, and uſes for the ſeparating his grain from the chaff. It conſiſts of an oblong wooden box, one end of which is cloſe and ſomewhat rounded, while the upper half of the other or ſquare end is open. The fans are thin pieces of wood fixed to an axle ſituated within the box at its rounded end. The axle is turned ſwiftly by a handle on the outſide of the box, and

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and the fans produce a briſk breeze or ſtream of air which comes out of the open end of the box. The grain is put into a wooden baſket at the top of the box. This baſket is of the form of a truncated pyramid with its narrow end loweſt. The aperture at its bottom is ſlightly covered by a falſe bottom, which is made to move to and fro, when the axle is turned on which the fans are placed, and thus lets down the grain gradually in front of the fans. The heavy grain falls acroſs the ſteam of air produced by the fans, and is received into a meaſure placed below, through an aperture at the front of the box. The lighter grain is blown towards the open end of the box, and is taken out from time to time. The chaff is blown entirely out of the box.

*Carriages of various ſorts are alſo uſed by farmers; but as theſe are not peculiar to this, more than to many other branches of buſineſs, we account it unneceſſary to give a particular deſcription of them. It may be proper, however, to take notice of a moſt unprofitable practice in many parts of England of uſing teams or waggons drawn by a great number of horſes in farming buſineſs. The experience of the moſt reſpectable farmers and others, appears now to have demonſtrated that the moſt advantageous mode in which draught horſes can be uſed, conſiſts of employing them in ſingle carts, and that the weight of an additional cart is more than compenſated by other circumſtances. The following judicious remarks upon the ſubject have been made by different writers.—" The horſes of Cumberland ‡ are not of a large ſize; one fifteen hands high, of a light form, that will anſwer either for riding or drawing, ſeldom draws leſs in a ſingle-horſe cart than 11 cwt. The common load for a draught horſe of that ſize, is 15 cwt. The carriers from Brompton to Newcaſtle, over a hilly country, carry frequently 18 cwt. We met a boy 18 years old, a carrier from Longton to Newcaſtle, driving five carts, in which were four tons, in each cart 16 cwt. A ſingle horſe cart carries ten pigs of lead of twelve ſtone each, which is 11 cwt. It may therefore be fairly concluded, that a common load for a ſingle horſe cart will be about 15 bwt.

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‡ *Annals of Agriculture*, vol. xxiv.

« In moſt countries a two-horſe cart ſeldom carries more than 20 cwt; nor a three-horſe cart more than 30 cwt. In Cumberland, a boy or girl drives two ſingle-horſe carts that carry 30 cwt. Of courſe two horſes yoked in ſingle-horſe carts, will draw as much as three horſes yoked in one cart.

“ A common carrier at Carliſle, who many years employed a waggon, has laid it aſide, and now uſes ſingle-horſe carts only; as he finds he can by that means carry much greater weights.

“ The ſuperior goodneſs of the roads in Cumberland may in a great meaſure be attributed to the univerſal uſe of ſingle-horſe carts. Wherever waggons are uſed they are the deſtruction of roads, eſpecially in hilly countries where they are obliged to lock the wheels; the banks are in a manner ploughed up with them, and the nine-inch wheels are in reality no more than three-inch wheels, by the artful mode of laying on the middle courſe of tire. Inſtead of being nearly exempted from tolls, every horſe drawing in a waggon ought to pay treble of what ſhould be exacted from a horſe drawing in a ſingle-horſe cart. Of what uſe are waggons except

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to deſtroy the roads? It is clear that the ſame number of horſes yoked in ſingle-horſe carts will draw more than when yoked ſix or eight together. Single-horſe carts are eaſier loaded and unloaded, are much more handy for almoſt every purpoſe; and ſix or eight may be driven by a man and a boy, which is a trifling additional expence. If a middle-ſized Cumberland horſe draws 15 cwt. a large ſtrong waggon-horſe will as eaſily draw 20 cwt. and which we know is done in ſome parts of the kingdom.

"Few countries can produce examples of greater draughts by a ſingle horſe, on a common road, than Dumbartonſhire. A waggon containing eighty ſtone of hay, 16 lb. to the ſtone, each pound containing 23½ ounces at an average, is an ordinary draught of one horſe to Glaſgow, &c at the diſtance of twelve and fourteen miles. Sometimes the load is 100 ſtone, which is equal to at leaſt 16 cwt. average. Draughts for a ſingle horſe from Leven printfields to Glaſgow, at the diſtance of eighteen or nineteen miles, at one rake, are ſtill greater. The waggon is commonly loaded with goods from 20 to 30 cwt. The ſame horſe generally goes loaded twice a week to Glaſgow, and returns loaded. The waggons employed by the printfields are covered, and conſequently heavier than common waggons for hay or corn.

"Two-horſe carts have gone much into diſuſe, becauſe two horſes in ſeparate carts will carry at leaſt one-third more weight, and with greater eaſe. Whatever part of the load is before the centre of gravity, which is always in the axle, reſts conſtantly on the horſe yoked in the ſhafts. Going down a hill, this burden muſt be greatly increaſed, and always in proportion to the ſteepneſs of the deſcent. But this is not all the evil. Unleſs the line of the draught of the foremoſt horſe be always in the line from the hook of his hams to the middle line of the axle, he will be pulling down the other horſe's back, or, in other words, will be giving him more weight to carry. The traces are generally fixed about the pin of the teams, which throws the line of the fore horſe's draft (behind that pin) a conſiderable angle above the axle. From which it is plain that the horſe in the traces muſt either not draw at all, or muſt bring additional weight on the other horſes; which is always in proportion to the force with which he draws, and the largeneſs of the angle which the line of his draught makes with the line betwixt the hook of his hams and the axle of the cart. Beſides, unleſs the driver be more careful than ordinary to keep the trace horſe to his duty, the other poor animal has not only this great weight to carry, but all the load to draw. In the long plough with four horſes the ſame reaſoning holds (only ſubſtituting the muzzle of the plough for the axle of the cart), as far as the drawing is concerned; and even in a plough with two horſes, unleſs the back-ropes are ſo adjuſted that the theats are in a ſtraight line from the hook of the hams to the ſwingletree, the better a horſe draws, the more weight he muſt bring on his back. Skilful farmers indeed ſay that the weight of the furrow muſt in ſome degree reſt on the horſes necks, by means of the back ropes. This may be a reaſon for the theats being ſtraight, but not for their being bent upwards."

SECT.

SECT. II.

OF PREPARING LAND FOR CROPPING, BY REMOVING OBSTRUCTIONS AND BRINGING THE SOIL INTO A PROPER STATE.

1. *Of removing Stones.*

Importance of removing ſtones.

IT is of the utmoſt importance to have land effectually cleared of ſtones, before undertaking any agricultural operation upon it; for by means of them there is frequently more expence incurred in one ſeaſon, by the breaking of ploughs and the injury ſuffered by the cattle and harneſs, than would remove the evil. It has alſo been obſerved that the ſoil round a large ſtone is commonly the beſt in the field. It may be conſidered as purchaſed at a low rate by removing the ſtone. At any rate, ſuch ſtones muſt be removed before the ground can be properly cultivated: for whether a large ſtone occupy the ſurface, or lie beneath it, but within reach of the plough, a conſiderable ſpace around it cannot be ſtirred by that inſtrument, and is therefore uſeleſs. Even the reſt of the field where ſtones abound muſt be laboured in a more ſlow and tedious manner, on account of the caution neceſſary to avoid the danger which they produce.

The ſtones which impede the improvement of land are, 1ſt, looſe ſtones, or ſuch as are thrown up to the ſurface by the plough; and, 2dly, ſitfaſt ſtones, which are either upon or immediately below the ſurface, but are of ſuch magnitude that they cannot be ſtirred by the

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the plough. The firſt kind of ſtones may uſually be eaſily removed by being gathered and carried off. When land is laid down for hay, ſuch ſtones are often improperly thrown in heaps into the furrows, where they ever after continue to interrupt the plough, or are dragged again by the harrows over the land. Inſtead of proceeding in this manner, they ought to be carried wholly off the field in carts at the drieſt ſeaſon of the year, and placed in ſituations in which they may be rendered uſeful to the farm. In this point of view, ſtones are ſometimes of conſiderable value for making concealed drains, or for making and repairing the roads through a farm, and alſo for the repairs of ſome kinds of fences.

The only writer upon agriculture who has in any caſe objected to the propriety of clearing land of ſmall ſtones, is probably Lord Kaimes. In ſome parts of the ſouth of Scotland, and particularly in Galloway, the ſoil is ſaid to be compoſed in a great meaſure of gravel, and of ſtones of a ſmooth ſurface, as if worn by the running of water. After being ploughed, the whole ſurface of every field appears to be compoſed of looſe ſtones lying almoſt in contact with each other. Some induſtrious farmers, with great labour, collected and removed the ſtones from a few of their fields, with a view to their improvement; and the reſult is ſaid to have been, that the ſucceeding crops were wholly blighted in the tender blade, and never came to maturity. The ſtones upon the ſurface were ſuppoſed to have prevented the exhalation of the moiſture from the ſhallow and extremely porous and open ſoil which they covered: and they were alſo ſuppoſed to have contributed to foſter the young plants, by reflecting powerfully from their ſmooth ſurfaces the ſun's rays in every direction around them: but when they were removed, the ſoil, in that bleak climate, became at once too cold and too dry for any purpoſe of agriculture. The farmers, therefore, who had with ſo much toil and coſt removed the ſtones from part of their lands, could think of no better remedy than, with equal toil, to bring them all back again, and carefully replace them upon their fields. It is added, that the ſoil immediately reſumed its wonted fertility. The truth of this anecdote has never been conteſted; and there is no doubt that it has long been current in the ſouth of Scotland, both previous to its publication by Lord Kaimes, and after that period, among a claſs of perſons who are very unlikely to have been acquainted with his writings. It is poſſible that the replacing the ſtones was the beſt remedy for the want of fertility in the ſoil which its cultivators had within their reach: but it is probable that they might have found it of more importance to have covered the ſurface of their land with a ſubſtantial coat of clay marl, or even with almoſt any kind of earth or clay obtained from the bogs and ſwamps that uſually abound in theſe countries, providing only they could obtain a quantity of lime to add to it. In this way, poſſeſſing land whoſe bottom was very pervious to moiſture, they might have obtained a ſoil ſuited to every purpoſe of agriculture; whereas, in its preſent ſtate, it muſt remain for ever unfit to be touched by the ſcythe.

With regard to large or ſitfaſt ſtones which cannot be removed by any ordinary effort, they uſually either appear fully above the ſurface or are concealed immediately under it. For the ſake of diſcovering concealed ſtones, it is ſaid to be a cuſtom in Yorkſhire,

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when they intend to reduce waſte and rude land under the plough, in the firſt place, carefully to go over the whole ſurface with ſharp prongs, which at the diſtance of every 12 or 14 inches they thruſt into the ground to the depth of above a foot, and wherever a ſtone meets the prong they mark the ſpot with a twig, a bit of wood, or ſome other object. They afterwards trace all the marks, and remove every ſtone before they touch the land with the plough.

Concerning the modes which have been adopted for removing large ſtones out of the way of the plough, one of the ſimpleſt is the following: A pit or hole is dug beſide the ſtone, 16 or 18 inches deeper than the height or thickneſs of the ſtone. A number of men are then aſſembled, who tumble it into the pit. It is immediately covered up with a part of the earth that came out of the hole; and the reſt of the earth is ſcattered over the field, or employed in bringing to a level with the reſt of the ſoil the ſpot where the ſtone formerly lay. As the ſtone now remains at a greater depth than the plough can reach, it is no longer an impediment to agriculture. In performing this operation, however, the workmen muſt attend to the nature of the ſoil, and take care that the weight of the ſtone do not bring down the ſide of the pit, which might be attended with dangerous conſequences. To obviate any hazard of this kind, it is always proper to have at hand a ſtout plank, which ought to be laid acroſs the pit or hole, immediately under the neareſt corner or edge of the ſtone. With this precaution, a ſingle man may uſually perform the whole operation of burying ſtones or pieces of rock of very great ſize and weight.

By the above operation, however, the ſtones are utterly

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terly loſt; whereas they may ſometimes be of conſiderable value for fences or other buildings. When this is the caſe, they muſt be broken to pieces before they are removed. With this view it is to be obſerved, that a great variety of ſtones have ſome thin veins, which being found, wedges can be driven into them by large hammers, ſo that they may be eaſily broken. For ſuch operations ſpades and pick-axes are neceſſary to clear away the earth, and a large and a ſmall lever to turn the ſtones out of the ground. Hammers and wedges are alſo requiſite, with carts, to remove the fragments from the field. In the Statiſtical Account of Scotland, (vol. xix. p. 565. pariſh of Maderty), we are told that "the Rev. Mr Ramſay, the preſent incumbent, who occupies a piece of land full of ſitfaſt ſtones, conſtructed a machine for the purpoſe of raiſing them. It operates on the principles of the pulley and cylinder, or wheel and axis, and has a power as one to 24; it is extremely ſimple, being a triangle, on two ſides of which the cylinder is fixed; it can be eaſily wrought and carried from place to place by three men. A low four-wheeled machine of a ſtrong conſtruction is made to go under the arms of the triangle, to receive the ſtone when raiſed up. This machine has been already of great uſe in clearing ſeveral fields of large ſtones in this place and neighbourhood."

It is evident, that the machine here deſcribed is only valuable for getting ſtones out of the way in the groſs and unbroken; and, accordingly, we learn that ſtone fences are almoſt unknown in the pariſh of Maderty.

Where ſtones are valuable, therefore, and the operation of breaking them with hammers and wedges is

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found impracticable or too laborious, it will be neceſſary to blaſt them with gunpowder. To perform this operation properly, however, conſiderable experience is requiſite; for it is ſaid, that a ſkilful workman can in moſt inſtances, by the depth and poſition of the bore, contrive to rend ſtones into three equal pieces without cauſing their fragments to fly about. In time of war, however, the expence of gunpowder is apt to become very great. With a view to diminiſh the coſt of that article, it has been ſuggeſted, that it is proper to perform the operation not with gunpowder alone, but with that article of a good quality, mixed up with about one-third of its bulk of quicklime in fine powder. We are aſſured that this compoſition poſſeſſes as much force as an equal quantity of pure gunpowder, and it is even alleged, that the proportion of quicklime may be increaſed with advantage. How the ſtrength of gunpowder ſhould be ſo much augmented by the addition of quicklime, we do not know. Perhaps it may add to the force of the exploſion by undergoing a chemical decompoſition of its parts, as it has of late been ſuſpected, that this mineral is by no means a ſimple or uncompounded body.

Where a field is very greatly overrun with concealed ſtones, the moſt effectual method of getting quit of them, and of rendering it permanently arable, conſiſts of trenching it wholly by the ſpade. Nor is this always the moſt expenſive mode of proceeding. The trenching can be done at the rate of from 3l. to 4l. per Scots acre, which is one-ſixth larger than an Engliſh acre, allowing at the ſame time the ſtones or their price at the quarry to the labourers. In this way, the expence of ploughing the field is ſaved. The ſoil is deepened to the utmoſt extent of which it is capable, and can be laid out in the form moſt convenient for cultivation. In Dr Anderſon's report of the ſtate of agriculture in Aberdeenſhire, it is ſaid that the expence of trenching an acre to the depth of from 12 to 14 inches, where the ſtones are not very large and numerous, runs from 4d. to 6d. a fall, which is from 2l. 13s. to 4l. per Scots acre. Ground that has been formerly trenched, is ſometimes done as low as 2d. per fall, or 1l. 6s. 6d. per acre. Hence, in conſequence of the practice of trenching ground by the ſpade being not unfrequent in Aberdeenſhire, workmen have become expert, and by competition have rendered the price extremely moderate. It is to be wiſhed that the ſame practice were more frequent in other parts of the country, as it would have a tendency to introduce a taſte for the moſt correct and perfect of all modes of labouring the ſoil, and would alſo occupy a conſiderable part of the population of the country, in the moſt innocent and healthful of all employments, that of agriculture.

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2. *Of Draining.*

Importance of draining.

It has already been remarked, that the preſence of moiſture is of the utmoſt importance to the ſucceſs of vegetation. At the ſame time, as muſt neceſſarily happen with every powerful and active agent, the too great abundance of water is no leſs pernicious to many plants, than an entire want of it. When it ſtagnates upon the ſoil, it decompoſes or rots the roots and ſtems of the moſt valuable vegetables. Even when it does not remain on a ſpot round the whole year, its temporary ſtagnation during the winter renders the land unproductive. Seaſons

ſons of tillage are often loſt, and in wet years the crop muſt always be ſcanty and precarious. When in graſs, the land can only produce the coarſeſt and moſt hardy vegetables, which can reſiſt the chill or cold ſtate of the ſoil, or the fermentation which is often produced by ſudden warmth while the water remains upon the ground. Hence ariſes the importance of draining, by which arable land is rendered manageable, is made to dry gradually and early in the ſpring, and the corn is increaſed in quantity and weight; and by which, in paſture lands, the graſſes are made to change their colour and to loſe their coarſe appearance, and the finer kinds of plants are enabled to flouriſh. Even the climate is, by means of draining, very conſiderably improved. It is rendered leſs cold during the winter, and by diminiſhing in hot weather the exhalations from the ſoil, its ſalubrity both to animal and vegetable life is greatly increaſed. Every kind of grain comes earlier to maturity. The harveſt is leſs precarious, and the diſeaſes are baniſhed which aroſe from a damp ſoil and a humid atmoſphere.

Land is rendered wet by rain or by ſprings.

The water which ſtagnates upon the ſurface of a ſoil may originate from two cauſes. It may deſcend upon it in the form of rain, or it may aſcend from ſprings or reſervoirs of water in the bowels of the earth. The rules for draining land which is rendered too wet for the purpoſe of agriculture are different, according to the cauſes which occaſion the wetneſs. We ſhall firſt take notice of the moſt approved modes of draining, when the exceſſive moiſture is occaſioned by rain or ſurface water ſtagnating upon the land; we ſhall afterwards ſtate the plan of draining to be adopted, when the wetneſs ariſes from ſprings or water ariſing out of the earth;

and, laſtly, we ſhall give an account of the mode of draining what are called landlocked bogs, from their being ſituated upon a lower level than the adjacent country.

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§ 1. *Of Draining Lands rendered wet by the ſtagnation of rain water upon their ſurface.*

Drains are open or hollow.

To relieve land from rain water that is apt to ſtagnate upon it, two kinds of drains have been adopted. Of theſe, ſome are called *open drains*, from their being expoſed to view in their whole length. The other kind receives the appellation of *hollow drains*, from their being covered, ſo that their exiſtence is not apparent to a ſtranger, nor is any part of the land loſt in conſequence of their being made. Hollow draining is ſometimes avoided on account of the great immediate expence with which it is attended, and in ſome ſituations it is altogether inadequate to the object in view. There are ſome ſoils that being chiefly compoſed of a ſtiff clay, poſſeſs ſo great a degree of tenacity as to retain water upon every trifling depreſſion of their ſurface, till evaporation carries it off. It is in vain to attempt to drain ſuch ſoils by hollow channels below ground, as the water will never be able to filtrate through the ſoil ſo as to reach the drain. In ſuch ſituations, therefore, open draining is the only mode that can be adopted for clearing the ſoil of ſurface water.

Hollow drains, when inapplicable.

It alſo ſometimes happens that on ordinary ſoils, hollow drains would ſpeedily be rendered uſeleſs. This muſt take place where the admiſſion of ſurface water cannot be avoided, and, from the figure of the adjoining lands, muſt be very greatly augmented in time of heavy rains. In ſuch caſes, a cloſe or hollow drain

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drain would ſpeedily be choked up by the ſand, and ſoil brought down by ſudden and violent torrents. In theſe ſituations, therefore, open drains can alone prove uſeful.

Draining of clay ſoils.

Soils formed of a tenacious clay can only be drained by being laid up properly in ridges which are high in the middle, and have furrows at each ſide for carrying off the water. The great art of preſerving land of this deſcription, therefore, free from ſuperfluous moiſture, conſiſts of laying out every field in ſuch a direction as that all the furrows between the ridges may have a gradual deſcent to a common ditch or drain for carrying off the water. Where at any particular ſpot the regularity of the deſcent is interrupted, croſs furrows muſt be kept open with the ſame view. The ridges muſt alſo be laid up in ſuch a form as to allow the water to deſcend from the ſummit in the middle to the furrows on each ſide. If the ridges, however, are too high in the centre, there will be a danger that in heavy rains the ſoil may be waſhed from the ſummit down into the furrows, which would produce the double evil of impoveriſhing the centre of every ridge, and of choking up the furrows, and rendering them unfit to drain the land.

The diſtinguiſhed ſucceſs of the Flemiſh huſbandmen, and alſo of the farmers in the central countries of England where this kind of ſoil abounds, ſufficiently demonſtrates the practicability of preſerving it in a due degree of dryneſs for the moſt valuable purpoſes of agriculture. In theſe Engliſh counties, and in Flanders, the general mode of drying land conſiſts of ploughing it up in high and broad ridges, from 20 to 30, and even 40 feet wide, with the centre or crown three or four ſour feet higher than the furrows. By attentively preſerving the furrows in good order, and free from ſtagnating water, the land is kept in a dry ſtate, and all kinds of crops flouriſh.

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Draining in the Carſe of Gowrie.

The mode of ridging and croſs-furrowing the clay ſoil of the Carſe of Gowrie, Perthſhire, has been thus deſcribed by George Paterſon, Eſq. of Caſtlehuntly in that county. "There are certain large common drains which paſs through the diſtrict in different directions, ſufficiently capacious to receive the water drained from the fields by the ditches which ſurround them, and of ſuch a level as to carry it clear off, and to empty their contents into the river Tay. There are alſo ditches which ſurround every farm, or paſs through them as their ſituation may require, but in ſuch manner as to communicate with every field upon the farm. Theſe ditches are made from two to four feet wide at top, and from one and a half to one foot at bottom; a ſhape which prevents their ſides from falling in: but even then they muſt be cleanſed and ſcoured every year at a conſiderable expence. If the fields be of an uniform level ſurface, the common furrows between the ridges, provided they be ſufficiently deepened at their extremities, will ſerve to lay the grounds dry; but, as it ſeldom happens that any field is ſo completely free of inequalities, the laſt operation, after it is ſown and harrowed in, is to draw a furrow with the plough through every hollow in the field which lies in ſuch a direction that it can be guided through them, ſo as to make a free communication with any of the ditches which ſurround the farm, or with any of the furrows between the ridges, which may ſerve as a conductor to carry the water off to the ſurrounding ditches. When this track is once opened

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opened with the plough, it is widened, cleared out, and ſo ſhaped with the ſpade, that it may run no riſk of filling up. Its width is from ſix inches to a foot, according to its depth, which muſt depend upon the level of the field; but the breadth of a ſpade at bottom is a good general rule. It frequently happens that there are inequalities in ſeveral parts of the ſame field, which do not extend acroſs it, or which do not paſs through it in any direction that a plough can follow; but which may extend over two ridges, or one ridge, or even part of a ridge. Such require an open communication to be made with any furrow, which may ſerve as a conductor to carry off the water, which is always made with the ſpade. All theſe open communications are here called *gaas*, and to keep them perfectly clear is a very eſſential object of every Carſe farmer's attention."

"It is the general practice in the Carſe to have head-ridges, as they are called, at the two extremities of each field; that is, the ground upon which the plough turns, is laid up as a croſs ridge, higher in the middle and falling off at each ſide, ſo that a gaa is made in the courſe of the inner furrow, with which the whole furrows between the longitudinal ridges communicate, and into which they pour all their ſurface water, which is carried off by gaas or openings cut through the head ridges, and emptied into the adjoining ditches which convey the water to the main drain. Beſides all this, an experienced Carſe farmer takes care that his lands be carefully ploughed, and laid up equally without inequalities that can hold water, and that the ridges be gradually rounded, ſo that the ſurface water may neither lodge nor run ſo rapidly off as to injure the equal fertility of the field."

Rules for making open drains.

With regard to the general rule for making open drains, it may be obſerved, that their depth and wideneſs muſt always in ſome meaſure be left to the judgement of each particular huſbandman, that they may be varied according to the variety of ſoils and ſituations. Upon the whole, however, the width at bottom ought to be one-third of that at top, that, by being ſufficiently ſloped, the ſides may be in no danger of falling in. The fall or declivity alſo ſhould be ſuch as may carry off the water, without ſtagnation, and along with it any graſs and other looſe and light ſubſtances that may get into the ditch. At the ſame time, care ought to be taken to lead the drain in ſuch a direction down any ſteep declivity that may occur in an oblique manner, that the water may not have too rapid a motion, as it would otherwiſe be apt to form inequalities in the bottom, and to wear down the ſides. In moſs and very ſoft ſoils drains require to be of conſiderable width, on account of their tendency to fill up; and their breadth at top muſt exceed that at the bottom in a greater degree than the proportion already mentioned. In all caſes in which a ditch is intended for a drain only, and not to be uſed as a fence, none of the earth thrown out of it ought to be allowed to remain upon the ſides, but ſhould be ſpread abroad upon the land, or uſed in filling up the neareſt holes. When this is not done, the utility of the drain is injured by the ſurface water being prevented from reaching it, and by the tendency which this weight of earth has to cauſe the ſides to fall in; the difficulty of ſcouring or cleaning it is thus alſo much increaſed. If it be neceſſary, however, to

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uſe the ditch, and the earth thrown out of it, as a fence, a deep furrow ought to be made along the back of the mound of earth, with openings in convenient places into the ditch for tranſmitting to it the water collected in the furrow.

In plantations, open drains are the only kind that can be uſed, as the roots of the trees would be apt to choke up covered drains. In paſtures, ſmall and narrow open cuts, made with the plough or otherwiſe, are often extremely uſeful, to carry off ſtagnating water and a part of the rain as it falls. The only objection to them is, that they are eaſily ſtopt by the trampling of the cattle; but, on the other hand, they are eaſily reſtored. Concerning all open drains, indeed, it muſt be remembered, that they require to be cleaned out at leaſt once a-year; and when this proceſs is neglected for any length of time, it becomes more difficult, and the drains loſe their effect. Hence, though open drains are originally cheaper, yet, by the neceſſity of annual repairs, they ſometimes become ultimately more expenſive than covered or hollow drains, to the conſideration of which we ſhall next proceed.

Nature and hiſtory of hollow drains.

Hollow drains, in which the water is allowed to flow along a bed of looſe ſtones, or other porous materials that are covered with a bed of earth in which the operations of the plough can proceed, bear a near reſemblance to that part of the conſtitution of nature by which water flows in various channels along beds of porous ſtrata in the bowels of the earth, and coming to the ſurface in various ſituations, ſupplies ſprings and the conſtant flow of rivulets and of the largeſt ſtreams. The practice of hollow draining was known in a very remote antiquity. It is ſaid that the preſent Perſians, as formerly mentioned, are ſupplied by means of hollow drains with water in their moſt fertile fields, though they know not from whence the water is brought, and are unacquainted with the arts by which a more ingenious people, in former times, contrived to deprive one part of the ſoil of its ſuperfluous moiſture with a view to enrich another. The ancient Roman writers, Cato, Palladius, Columella, and Pliny, particularly mention the practice of hollow draining. They knew the kind of ſoils in which theſe drains are uſeful, and the propriety of directing them obliquely acroſs the ſlope of the field. They filled them half way up with ſmall ſtones, and for want of theſe with willow poles, or even with any coarſe twigs or other ſimilar materials twiſted into a rope. They alſo fortified the heads of their drains with large ſtones, and their mouths or outlets with a regular building; and they carried the whole drain to the depth of three or four feet.

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As already mentioned, hollow drains are of little value in a ſoil that conſiſts of a ſtiff clay, and are chiefly uſeful where, from whatever cauſe the wetneſs may reſult, the ſoil is ſufficiently porous to allow the moiſture to percolate to an internal drain.

If the field propoſed to be drained lie on a declivity, great care ſhould be taken to make hollow drains in a direction ſufficiently horizontal to prevent a too rapid fall of the water, which might wear the bottom uneven, and have the effect to choke, or, as it is ſometimes called, to *blow up* the drain, whereby in certain ſpots in the field artificial ſprings would be formed.

Rules for making hollow drains.

Concerning the ſeaſon for executing drains, diſcordant opinions are entertained. Some prefer winter, others ſummer. Where much work is to be accompliſhed,

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compliſhed, a choice of ſeaſons may not indeed be left to the huſbandman. Some farmers, however, when they have the choice of time, always prefer ſummer for this employment, being then able to execute the cuts in a neater manner without that kneading of the ſoil which takes place in winter, which they think hurts the uſefulneſs of the drain, by ever after preventing the water from eaſily finding its way to it; beſides, that it is eaſier to bring the ſtones or other materials to the ſpot in ſummer than in winter. Others, however, prefer draining in winter, becauſe in the caſe of a clay ſoil the labour is at that ſeaſon much eaſier; and alſo becauſe labourers are then uſually moſt eaſy to be obtained.

The depth and width uſually adopted for hollow draining is very various, according to the nature of the ſoil and the ſituation of the field. When the practice firſt came into general uſe, three feet is ſaid to have been the common depth; but, for many years paſt, it is ſaid that hollow drains ſeldom exceed 30 or 32 inches, and that more drains are of two feet, or 26 inches deep, than of any other. One general rule, however, cannot be neglected with ſafety, that the depth muſt be ſufficient to prevent the materials with which the drain is filled from being affected by the feet of horſes in a furrow while ploughing; twenty-four inches is perhaps too little for this purpoſe. A horſe's foot in a furrow is uſually at the depth of four inches or more. If ten inches additional be allowed for the materials employed in filling the drain, there will remain only nine or ten inches to ſupport the foot of a horſe exerting his ſtrength in the act of ploughing, which upon a porous ſoil ſeems ſcarcely ſufficient.

What are called *main drains*, which are thoſe intended to receive the water of ſeveral other drains, muſt always be ſomewhat deeper than the reſt, having more water to convey. As to the wideneſs of hollow drains, moſt farmers have of late been ſolicitous to render them as narrow as poſſible, becauſe by this means a great ſaving takes place of the materials uſed for filling them. If the ſtones are coupled at the bottom of the drain, that is, made to lean towards each other, ſo as to conſtitute a triangle, of which the bottom of the drain forms the baſe, the width need not be greater than one foot; nor perhaps is it even neceſſary to exceed this breadth where large ſtones are thrown in promiſcuouſly. That the ditches or cuts which are meant to be converted into hollow drains may be executed with neatneſs and care, a point of much importance to their uſefulneſs, it is thought prudent that the workmen ſhould not be paid according to the extent of ground which they open, but as day labourers. This, however, is more particularly the caſe with regard to filling the drains, an operation in which a ſtill greater degree of attention is neceſſary.

Materials with which hollow drains may be filled.

The materials uſed for filling drains have been various, according to the ſubſtances which different farmers have been able to obtain. Stones, however, are the moſt common, and alſo the beſt of all materials, on account of their permanency. If ſtones from quarries are to be uſed, and the drain formed like conduit at the bottom, the trench muſt be made at the loweſt part 16 inches wide, containing two ſide ſtones about ſix inches aſunder, and the ſame in height, with a cap or flat ſtone laid over, which ſecures the cavity. Such hollow drains are commonly uſed for permanent currents

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rents of water from ſprings, and are more expenſive than where no ſuch ſteady current exiſts, and the ſtones are either thrown in promiſcuouſly, or laid down ſo as to form triangular cavities. Small ſtones, however, ought not to be uſed for the bottom of a drain. Whether the ſtones are large or ſmall, they ought to be very clean, having no clay or earth adhering to them, and of the moſt hard and permanent quality that can be procured, with as little tendency as poſſible to moulder or decay in conſequence of alternate changes from wet to dry. They ought alſo to be laid in carefully, ſo as not to tumble down any earth, which might choke up their interſtices. The whole ſubject, however, will be better underſtood by a ſtatement of the way in which drains have been filled with ſucceſs by intelligent perſons.

The following directions are given by T. B. Bayley, Eſq. of Hope, near Mancheſter: "Firſt make the main drains down the ſlope or fall of the field. When the land is very wet, or has not much fall, there ſhould in general be two of theſe to a ſtatute acre; for the ſhorter the narrow drains are, the leſs liable they will be to accidents. The width of the trench for the main drains ſhould be 30 inches at top, but the width at the bottom muſt be regulated by the nature and ſize of the materials intended to be uſed. If the drain is to be made of bricks, 10 inches long, 3 inches thick, and 4 inches in breadth, then the bottom of the drain muſt be 12 inches; but if the common ſale bricks are uſed, then the bottom muſt be proportionably contracted. In both caſes there muſt be an interſtice of one inch between the bottom brick and the ſides of the trench, and the vacuity muſt be filled up with ſtraw, ruſhes, or looſe loofe mould. For the purpoſe of making theſe drains, I order my bricks to be moulded 10 inches long, 4 broad, and 3 thick; which dimenſions always make the beſt drain."

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The method which this gentleman purſues in conſtructing his main drains is ſtated by him to be the following: When the ground is ſoft and ſpongy, the bottom of the drain is laid with bricks placed acroſs. On theſe, on each ſide, two bricks are laid flat, one upon the other, forming a drain ſix inches high, and four broad, which is covered with bricks laid flat.—When the bottom of the trench is found to be a firm and ſolid body, ſuch as clay or marl, he formerly thought that it might not be neceſſary to lay the bottom with brick; but in this he has candidly acknowledged that he was quite wrong. By the runs of water, the alternate changes from wet to dry, and the acceſs of air, theſe hard bottoms were rendered friable, crumbled away, and let in all the drains, and allowed them to choke up, that were not ſupported by a bottom laid with brick or ſtone. When ſtones are uſed inſtead of bricks, Mr Bayley thinks that the bottom of the drain ſhould be about eight inches in width; and in all caſes the bottom of main drains ought to be ſunk four inches below the level of the narrow ones, whoſe contents they receive, even at the point where the latter fall into them.

The main drains ſhould be kept open or uncovered till the narrow ones are begun from them, after which they may be finiſhed; but before the earth is returned upon the ſtones or bricks, it is adviſable to throw in ſtraw, ruſhes, or bruſhwood, to increaſe the freedom of the drain. The ſmall narrow drains ſhould be cut at the diſtance of 16 or 18 feet from each other, and ſhould fall into the main drain at very acute angles, to prevent any ſtoppage. At the point where they fall in, and 8 or 10 inches above it, they ſhould be made firm with brick or ſtone. Theſe drains ſhould be 18 inches wide at the top, and 16 at bottom.

A mode of draining clay ſoils wet by rain or ſurface water, practiſed by Sir Henry Fletcher, Bart. with great ſucceſs, ſeems worthy of being here ſtated. The upper ſoil is of good quality; but being ſituated in a mountainous part of the country, the frequent rains kept the upper ſoil ſo full of water, that it produced only a coarſe graſs worth 3s. per acre. The inferior ſoil of clay was of great depth. The mode of draining which has been ſucceſsfully practiſed upon it is the following: "On graſs lands he digs 22 inches, or 2 feet deep; the firſt ſpadeful is of the turf, taken ſo deep, as where it ſeparates from the clay, which is dug carefully out, and preſerved unbroken graſs ſide up, and laid on one ſide of the cut; then, with a very ſtrong ſpade, 18 inches long, 6 inches wide at top, and 2 at the bottom, he digs a ſpadeful in the clay, which the men ſpread about the land, on the ſide of the drain oppoſite to where the turfs were laid, as far as poſſible from the drain, ſo as none may get in again. A ſcoop, to clear out the fragments in the bottom, follows, which are alſo ſpread in like manner. They are then ready for filling; and in doing this, he takes three ſtones of a thin flat form, two of which are placed againſt the ſides of the drain, meeting at bottom; and the third caps the other two. Thus, a hollow triangular ſpace is left to convey the water, which is ſubject to no accidents that can fill it up or impede the current.

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current. Stones always ſink deeper in the ground; and in the common method, this frequently cauſes ſtoppages by their being partly buried in the clay: but the triangle, when it ſubſides, does it regularly, and keeps its form and the paſſage for the water clear. One cart-load of ſtones, in this way, will do a conſiderable length of drain. They are carefully laid down by the ſide of the cut, with a ſhovel or baſket, and if there are any ſmall refuſe ſtones left on the ground after the drain is ſet, they are thrown in above. The ſtones being thus fixed, the ſods are then trimmed to the ſhape of the drain, and laid on them with the graſs ſide downwards, and none of the clay uſed in filling up.

The expence is a halfpenny per yard, the men earning 2s. and 2s. 6d. per day, at 10 yards diſtance from drain to drain. At 6 yards diſtance they anſwered well, but would not operate a cure, if more than 7 yards aſunder. At this laſt diſtance, therefore, the expence of draining an Engliſh acre, at ½d. per yard. would amount to 1l. 9s. 2d. the ſtones being not more than half a mile diſtant.

Not only ſtones and bricks, but alſo wood and other materials have been uſed for filling drains. Upon this point, Lord Petre expreſſes himſelf thus: "The drains filled with wood, and covered as uſual with ſtraw or ruſhes, are preferable to ſtones or any other kind of materials; the reaſon is, as the wood decays, the water continues to paſs. When filled with ſtones, and the drains ſtop up, which muſt be expected to take place in time, the earth becomes quite ſolid round the ſtones, and as they do not decay, the filtering of the water is for ever obſtructed: not ſo when buſhes or wood are uſed; continual filtering and draining are then for ever to be perceived; and by repeating the operation a ſecond time, cutting the drains tranſverſely of the old ones, the benefit of the filterings through the rotten wood is ſecured, and the ſpewing up of old, broken, and damaged drains corrected and carried off. Moreover, as buſhes form a much greater number of cavities than either ſtones or poles, they are leſs liable to ſtop up, and encourage filtering more than larger and more ſolid bodies. A load of buſhes containing 120 faggots, will do about 360 rods; and a load of ſtraw containing 120 bottles, the ſame: the load of buſhes is generally worth about 14s. and the ſtraw 18s. per load. I therefore calculate this expence about 12s. per acre, ditches a rod apart."

Richard Preſton, Eſq. of Blackmore, prefers, on twenty years experience, black thorns to every other material for filling drains. Wood is ſometimes uſed with this view, in the following manner: Two billets are placed at oppoſite ſides of the drain, and each is made to reſt upon the oppoſite ſide to that on which its lower part ſtands, ſo as to form with each other a St Andrew's croſs. The upper part of the croſs is filled with bruſhwood, laid longitudinally, above which ſtraw is placed croſs-ways, and the mould is thrown in over all.. This kind of drain is ſaid to have continued running in Berwickſhire for 30 years, and it is recommended by the author of the Agricultural Report of the county of Caermarthen, in Wales. He ſays, "The completeſt method I have yet known, is to cut the ſtrongeſt willows, or other aquatic bruſhwood, into lengths of about 20 inches, and place them alternately in the drain, with one end againſt one ſide of the bottom,

tom, and the other leaning againſt the oppoſite ſide. Having placed the ſtrong wood in this manner, I fill the ſpace left between them on the upper ſide with the ſmall bruſhwood, upon which a few ruſhes or ſtraw being laid, as before mentioned, the work is done. Willow, alder, aſp, or beech boughs, are exceedingly durable if put into the drain green, or before the ſap is dried; but if they are ſuffered to become dry, and then laid under ground, a rapid decay is the conſequence. I have ſeen willow taken out of a bog, after lying there thirty years, and its bark was as freſh and ſappy as if it had been recently cut from the hedge; and it is well known that beech laid green in the water will continue ſound for any length of time."

Another method of uſing wood conſiſts of fixing at every foot diſtance in the drain, a ſtick in the form of a ſemicircular arch, and of laying upon theſe longer branches or twigs longitudinally. Thus is a curved cavity, or arch, formed beneath, capable of ſupporting any weight of earth. For this purpoſe young wood is recommended, and in particular the prunings of larch.

Inſtead of wood or ſtone, in many places, it has of late become cuſtomary to fill the loweſt part of drains with ſtraw, and with that view to make uſe of wheat ſtubble as the cheapeſt kind of ſtraw. On this ſubject, Mr Vancouver, in his Report of the Eſſex huſbandry, remarks, that when the ſoil is a very cloſe and retentive clay, the drains ſhould be made proportionally near to each other, ſhallow, and filled with ſtraw only, it being totally unneceſſary to uſe wood or any more durable material upon land where the ſides of the drains are not likely to crumble in. He aſſerts that drains

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formed in this manner, through the tough and retentive clays, will be found in a ſhort time after the work is finiſhed, to afford over the ſtraw, with which the drain was filled, an arch of ſufficient ſtrength to ſupport the incumbent weight of the ſoil, and the caſual traffic of the field. "In 12 or 18 months it may be obſerved that the ſtraw, being of one uniform ſubſtance, is all rotted, and carried away, leaving a clear pipe through the land in every drain, into which the paſſage of the water may have been much facilitated, by a due attention to the filling of the drains with the moſt friable and porous parts of the ſurface the field might have afforded."

An improvement in filling hollow drains with ſtraw, conſiſts of twiſting the ſtraw into a rope, ſaid to have been deviſed by Mr Bedwell, of Eſſex. The rope of ſtraw is formed as large as a man's arm, and is placed at the bottom of the drain. The expence of draining an Engliſh acre of land with this material in Eſſex, is ſaid to ſtand thus:

For cutting and raking together an acre of wheat ſtubble, generally ſufficient for an acre of drains, - -	L. 0	2	0
Digging eight ſcore rods of drains,	0	13	4
Filling them up with ſtubble, -	0	2	8
Extra work with the common ſpade, on an average a day's work for a man, -	0	1	4
	L. 0	19	4

As in ſome ſituations it is an object of great importance to ſave the expence of materials commonly uſed in filling drains, a variety of devices have with that view been adopted. One of theſe is of the following nature. A drain is firſt dug to the neceſſary depth, narrow at bottom. Into the trench is laid a ſmooth tree, or cylindrical piece of wood, 12 feet long, 6 inches diameter at the one end, and 5 at the other, having a ring faſtened into the thickeſt end. After ſtrewing a little ſand upon the upper ſide of the tree, the clay or tougheſt part of the contents of the trench is firſt thrown in upon it, and thereafter the remainder of the earth is fully trod down. By means of a rope through the ring the tree is then drawn out to within a foot or two of the ſmaller or hinder end, and the ſame operation is repeated till the whole drain is complete. Such a drain is ſaid to have conducted a ſmall run of water a conſiderable way under ground for more than 20 years without any ſign of failure.

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Sod or pipe drains.

What is called the ſod or pipe drain conſiſts of a trench dug to a proper depth; after which a laſt ſpadeful is taken out in ſuch a way as to leave a narrow channel, which can be covered by a ſod or turf dug in graſs land and laid over it, the graſs ſide downwards. Such drains are ſaid to continue hollow, and to diſcharge well for a great number of years. Moſſes are ſaid to be drained in Lancaſhire nearly in the ſame manner, by leaving ſhoulders about a foot and a half from the bottom of the trench, and laying acroſs theſe pieces of dryed peat or turf, cut into lengths of 16 inches, and 8 or 9 inches in breadth.

In Buckinghamſhire, in graſs lands, the ſod drain is thus made: When the line of drain is marked out, a ſod in form of a wedge is cut, the graſs ſide being the narroweſt, and the ſods being from 12 to 18 inches in length. The drain is then cut to the depth required, but is contracted to a very narrow bottom. The ſods are then ſet in with the graſs ſide downwards, and preſſed as far as they will go. As the figure of the drain does not ſuffer them to go to the bottom, a cavity is left, which ſerves as a water courſe; and the ſpace above is filled with the earth thrown out.

Another invention for draining land is deſcribed in the agricultural report of the county of Eſſex. It conſiſts of a draining wheel of caſt iron, that weighs about 4 cwt. It is 4 feet in diameter, the cutting edge or extremity of the circumference of the wheel is half an inch thick, and it increaſes in thickneſs towards the centre. At 15 inches deep it will cut a drain, one half of an inch wide at the bottom, and 4 inches wide at the top. The wheel is ſo placed in a frame, that it may be loaded at pleaſure, and made to operate to a greater or leſs depth, according to the reſiſtance made by the ground. It is uſed, in winter, when the ſoil is ſoft; and the wheel tracks are either immediately filled with ſtraw ropes and lightly covered over with earth, or they are left to crack wider and deeper till the enſuing ſummer; after which the fiſſures are filled with ropes of ſtraw or of twiſted twigs, and lightly covered with the moſt porous earth that is at hand. Thus, upon graſs or ley lands, hollow drains are formed at a trifling expence, which anſwer extremely well. It is ſaid that 12 acres may be fully gone over with this draining wheel in one day, ſo as to make cuts at all neceſſary diſtances.

On ſheep paſtures a ſtill ſimpler mode of removing ſurface water is ſaid to be practiſed in ſome places. Wherever the water is apt to ſtagnate, a deep furrow is turned up with a ſtout plough. Thereafter, a man with a ſpade pares off the looſe ſoil from the inverted ſod, and ſcatters it over the field, or caſts it into hollow places. The ſod thus pared and rendered thin, or brought to the thickneſs of about three inches, is reſtored to its original ſituation, with the graſſy ſide uppermoſt, as if no furrow had been made. A pipe or opening is thus formed beneath it two or three inches deep in the bottom of the furrow, which is ſufficient to diſcharge a conſiderable quantity of ſurface water which readily ſinks into it. Theſe furrows, indeed, are eaſily choked up by any preſſure, or by the growth of the roots of the graſs; but they are alſo eaſily reſtored, and no ſurface is loſt by means of them.

Duration of hollow drains.

With regard to the duration of hollow drains, or the length of time that the water will continue to flow in them, and thereby to preſerve the ſoil in a proper ſtate of dryneſs, it muſt neceſſarily depend, in a great degree, upon the nature of the materials with which they are filled, and the care that has been taken to prevent their being choked up by any acceſſion of ſoft ſoil. Independent of this laſt circumſtance, a drain filled with ſtones, like the channel which ſupplies a natural ſpring, may endure for ever. Wood, with which many drains have of late years been filled, periſhes at certain periods according to its nature; but it does by no means follow, that the drain ſhould loſe its effect in conſequence of the deſtruction of the wood. If the earth over it form itſelf into an arch, the water will ſtill continue to flow. Accordingly, it is ſaid, that drains filled with buſhes and ſtraw have been known to run well after 40 years.

§ 2. *Of Draining Lands rendered wet by ſprings.*

Drains when the wetneſs is cauſed by ſprings.

Having thus ſtated the various modes that have been moſt ſucceſsfully adopted for draining lands of a ſuperabundant moiſture cauſed by rain or ſurface water, we ſhall proceed to conſider the way in which a ſoil may uſually be drained when its undue wetneſs is the conſequence of natural ſprings, or of water ariſing out of the bowels of the earth.

Nature of ſprings.

To underſtand the principles upon which land, rendered wet by ſprings, may be drained for the purpoſes of agriculture, it is neceſſary to attend to the materials of which the globe we inhabit is compoſed, and to the manner in which large quantities of water find their way into its bowels. The earth upon which we tread is by no means an uniform maſs of matter. It conſiſts of various layers or ſtrata of different ſubſtances, one placed over the other. Theſe layers or ſtrata are ſeldom ſituated horizontally, but almoſt always deſcend towards one ſide or the other. One part of a ſtratum or layer often aſcends and appears on the ſurface, while the other end or ſide of it deſcends obliquely to a great depth into the earth. Having done ſo, it frequently again bends upwards towards the ſurface; and indeed aſſumes almoſt all the variety of irregular forms and bearings that the imagination can conceive; ſometimes ſuddenly breaking off and giving place to other ſtrata or layers, and ſometimes continuing at one corner while the greater part of it ceaſes. Theſe ſtrata or layers, of which the earth is compoſed, may be conſidered, with a view to the explanation of our preſent ſubject, as of two kinds. Some of them are porous, and allow water to paſs through their ſubſtance, and to fill up all their cavities and interſtices, ſuch as ſand, gravel, ſome marls, and various kinds of porous rocks. Other layers, on the contrary, do not ſuffer water to enter into them; ſuch as clay, or gravel with much clay mixed with it, and rocks of a cloſe and compact nature, without any fiſſures or clefts in them.

It is next to be remarked, that it is chiefly upon high mountains that water exiſts, or is formed, in very great abundance. Not only do the mountains catch and break the paſſing clouds, which depoſite upon them the greateſt portion of their watery contents, but they would ſeem to have a power, when neither rain nor clouds appear in the ſky, of condenſing, attracting, or ſomehow forming water from the atmoſphere. In the great burning deſerts of Africa rain is ſcarcely known. The inhabitants build their houſes of clods of earth or of lumps of ſalt. A drizzling ſhower, which is apt to come once in ſeveral years, endangers every dwelling; and two hours heavy rain would lay a whole city in ruins; yet even there, wherever mountains exiſt, that is to ſay, naked rocks which abound in a few diſtricts of this wilderneſs, water is almoſt always found in their vicinity; and, in conſequence of the water, ſpots covered with the moſt luxuriant verdure are ſeen like iſlands amidſt the dreary tracts of moveable and unproductive ſand.

The upper part of mountains is very frequently covered with a layer of gravel, or looſe and open rock, into which water readily penetrates. Theſe porous layers or ſtrata deſcend gradually into the bowels of the earth, and convey along with them the water which they contain, and have received from the clouds. Under the porous ſtratum or layer of gravel are uſually ly layers of clay or of ſolid rock, through which the water cannot paſs, but along the upper part of which it flows. After deſcending, however, a certain length obliquely down towards the plain country, the layers of porous gravel uſually paſs under new layers or ſtrata of clay and other impervious materials. Thus, as the water in the gravel is confined between clay above and clay or rock below, and muſt deſcend along the gravelly channel which is pervious to it, ſtreams of water are formed in the bowels of the earth, which have their origin in high gravelly ſoils, and their outlets at any place in the low country, where any part of the beds of gravel or porous rock, along which they flow, happens to approach the ſurface, forming ſprings and rivulets, and, by their union or conflux, mighty rivers, which continue ſteadily to water the ſurface of the earth. Hence alſo, in very many ſituations, by digging pits into the earth, we at laſt reach a layer of pervious gravel or rock, containing a ſtream of water brought, perhaps, from the ſummit of a diſtant mountain; and ſuch pits can be uſed as wells for ſupplying water for every domeſtic purpoſe.

We have ſaid that the upper part of the face of a mountain is often covered with a bed of porous or gravelly ſubſtances capable of taking in water. Upon the ſurface, at a certain diſtance down the hill, a bed of clay begins. The water received above into the layer of gravel continues to deſcend with that layer for a conſiderable ſpace below the bed of clay; and thereafter the gravel ſuddenly ſtops, and the clay above unites with the clay beneath, or with ſome other impervious ſtrata upon which the gravel all the way reſted. In this ſituation, as the water contained in the gravel can proceed no farther, it hangs within the ſide of the hill as in a bag of clay; and a reſervoir is formed of water within the earth. When this bag or natural reſervoir is full, the water contained in it is preſſed upwards againſt the clay by which it is covered. It moiſtens this clay, and finds its way by chinks through all its weaker parts or pores. Thus a belt of ſoft and ſpouty land is formed upon the ſide of the hill; the mode of draining which is very eaſy. If a hole is dug into the earth near the bottom of the bag or reſervoir of water, ſo as to reach the layer of gravel, the water will inſtantly flow freely out, and, being no longer reſtrained, it will ceaſe to preſs upon the layer or ſtratum of clay that covers it, or to force a paſſage through its chinks; and the ſoil will conſequently be drained.

Principle on which land made wet by ſprings is drained.

Let it be ſuppoſed, that the porous ſtratum or layer of gravel, inſtead of ſtopping on the ſide of a hill, deſcends into a plain or level country, the water all the while paſſing along in its bowels; and that the gravel has a layer of clay below and another layer of clay above it. After it has reached and paſſed to a conſiderable diſtance along the valley, if the layer of gravel either ſuddenly ſtop and allow the layers of clay to come together, or if the gravel have too little thickneſs and capacity to allow the water which flows within it to paſs eaſily along, it will neceſſarily, from the new ſupplies of water which are continually deſcending, be preſſed upwards againſt the layer of clay which covers it: as, in the former caſe, the clay will be ſoftened, and the water will filtrate through all its weaker parts till it reach the ſurface, which it will keep conſtantly wet, and where it will ſtagnate in conſequence

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ſequence of the flat and level form of the country. Over the ſofteſt places, a coarſe verdure will ſpread, and the roots of the plants intertwining, will form ſhaking quagmires. In other places, the moſs plants, being the only ones which can thrive in the moiſt and ungenial ſoil which is thus produced, will rapidly ſpring up, and a moſs will be formed altogther unfit for any purpoſe of agriculture. To drain ſuch a ſoil, it is evidently only neceſſary to dig a pit or hole through the upper ſtratum of clay into the gravel, to give a free vent or iſſue to the water; which having thus found an eaſy paſſage to the open air, will ceaſe to preſs upon the incumbent layer of clay, or to render it moiſt. This clay will therefore ſpeedily become dry and collapſe; the moſs plants will wither, provided the ſurface is properly drained; and the whole ſoil will become ſolid and fit to be cultivated.

It ſometimes happens, as already noticed, that a piece of territory which lies low is rendered extremely wet by rain and ſpring water coming from adjacent high grounds, and lodging upon its ſurface, while, at the ſame time, it is ſo completely ſurrounded by eminences, or land-locked, that it cannot be drained at a moderate coſt; the conſequence of which is, that the water ſtagnates, and a moſs or bog is formed. The practical mode of draining ſuch a bog will be afterwards explained. In the mean time it may be remarked in paſſing, that the principles which we have already ſtated concerning the manner in which the globe is made up of various ſtrata, indicate the way in which ſuch a bog may be drained at a cheap rate. It is only neceſſary to dig a pit at the loweſt part of it, down through the clay, or other impervious layer that holds up the water, till a porous ſtratum is reached capable of conveying away the ſurface water down the country below ground to the ſea, or to ſuch rivers as it may chance to be connected with.

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The whole art of draining land where the wetneſs is occaſioned by water preſſing upwards from the bowels of the earth, depends upon theſe principles. It is an art whoſe importance is not yet ſufficiently appretiated, becauſe imperfectly underſtood, and becauſe it has not yet been carried in practice to its full extent. It is probable, however, that at no remote period it will be held in univerſal eſtimation, on account of the command of thoſe hidden ſtreams that are contained in the bowels of the earth, which it will give to mankind for the purpoſes of an improved agriculture, and for the ſervice of commerce in filling canals and giving motion to every kind of machinery. A diſpute exiſts about the original diſcovery of this art. The celebrated writer upon agriculture, Dr James Anderſon of Aberdeen, in his "Eſſays on Agriculture and Rural Affairs," publiſhed in 1775, was undoubtedly the firſt perſon who explained to the world the nature of the art of draining land rendered wet by ſprings, and the principles upon which it ought to proceed; having been led to the inveſtigation many years before, by his having fortunately ſucceeded in draining a bog by a ſinking a pit in it through the clay till an opening was made into the gravel or porous ſtratum, from which the water ruſhed up vehemently. In the mean while, it had happened that Mr Joſeph Elkington, poſſeſſor of a farm in England called Princethorp, in the pariſh of Stretton upon Dunſmore, and county of Warwick, almoſt as early as Dr Anderſon, had accidentally diſcovered that land might be drained in many ſituations by making a ſmall hole into the earth.

Diſpute about the firſt diſcoverer of the mode of draining land made wet by ſprings.

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Being a man of conſiderable natural ingenuity, though, it is ſaid, of little literature, he had the addreſs to take advantage of the diſcovery he had made, with a view to the improvement of his affairs. He therefore commenced the trade of a drainer of land; and by the novelty of draining land by a ſmall hole bored often at a conſiderable diſtance from the wetteſt part of it, and by conducting himſelf in a myſterious manner, he acquired great reputation, and was extenſively employed. This employment he appears to have merited, as his operations were attended with very great ſucceſs. After the eſtabliſhment of the Board of Agriculture, its members, who appear to have been unacquainted with Dr Anderſon's publication, ſuppoſed Mr Elkington to be the only diſcoverer and poſſeſſor of the art of draining land wet by ſprings in the way now mentioned; and upon their recommendation, parliament beſtowed a reward of 1000l. upon him. It was ſurely an unfortunate circumſtance, that the firſt premium granted uppon the recommendation of this board, ſhould have proceeded upon a error, as it undoubtedly did; for although Mr Elkington had the merit of being the firſt who introduced this art extenſively into practice, there is no doubt that Dr Anderſon, by whom alſo it was diſcovered, was the firſt who explained its principles to the public, and that at a period when Mr Elkington's ſecret remained with himſelf. After all, however, it is not to be ſuppoſed that the theory of this art was abſolutely unknown, although theſe perſons appear to have been the firſt who propoſed to apply it extenſively to the purpoſes of agriculture. It is ſaid that the practice is very ancient in Italy, when a well is dug, to avoid the expence of going to a great depth, by boring

ing with an auger in the bottom of the pit, in the hope of reaching the porous ſtratum which contains the water. And in Germany it appears, as will be afterwards noticed, that the practice has long exiſted of draining land-locked bogs, by letting down the water by means of a pit through the impervious clay, to a porous ſubſtratum.

We ſhall now proceed to ſtate the moſt approved practical modes of draining land that is rendered wet by ſprings, or water aſcending out of the earth; and as the Board of Agriculture inſtructed Mr John Johnſton, land ſurveyor, to inſpect Mr Elkington's principal drainings of this ſort, and to give an account of them, we ſhall give all due attention to the contents of the report made out by that gentleman, which is underſtood to have been executed with much fidelity and accuracy; though we ſhall alſo exhibit, at the ſame time, the practice of other intelligent perſons upon the ſame ſubject.

Practical rules for draining land made wet by ſprings.

In the practice of this art it will readily occur, that it is of the utmoſt importance to obtain a knowledge of the internal ſtructure of the earth, and of the manner in which its various layers or ſtrata ſucceed, and are uſually intermingled with each other. This object, however, can only be attained in any conſiderable degree of perfection by obſervation and experience. There are ſeveral ways, however, by which a man of ſagacity and reflection may greatly abridge the difficulty of this ſtudy, ſo as in a ſhort time to enable himſelf to practice the art of draining with conſiderable ſucceſs. The ſureſt way of aſcertaining the inclination of the different ſtrata, or the way in which they lie upon each other and the direction in which

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they deſcend into the earth, conſiſts of examining the bed of the neareſt rivers, and the appearance of their banks when ſteep and broken, ſo as to lay bare the different ſtrata of earth adjoining to them. Pits, quarries, and wells, that have been dug in the neighbourhood, may alſo be examined with the ſame view. Ruſhes, ſmall elder buſhes, and other plants which grow on the wetteſt ſoils, alſo frequently afford ſymptoms of the line under which an internal reſervoir of water is placed, and is preſſing upwards from wanting a free paſſage below ground.

To drain the ſide of a hill.

It is often of much importance, even in ſheep countries, to drain the ſide of a hill, not only becauſe wet land is more unproductive than that which is properly drained, but becauſe the ſuperabundance of moiſture is apt to introduce and to keep up among the flock that deſtructive and incurable diſeaſe, the *rot*, for which draining is an almoſt infallible preventive. It is cheaply executed in ſuch ſituations, becauſe the drains for collecting and leading off the water, may uſually be left uncovered. Let it be ſuppoſed then, that in conſequence of internal ſprings at a certain diſtance down the declivity of a hill, or upon any other deſcending ſurface, the ground becomes wet and ſpouty, and unwholeſome for ſheep, and unfit for agriculture; the beſt mode of proceeding with a view to drain it is this. It ought to be recollected, that the cauſe of the wetneſs is this: The rain water at the ſummit of the high ground is received into a porous ſtratum of gravel, with which it deſcends down the ſide of the hill, till it comes to be covered with a clayey ſoil. After deſcending under the covering of clay to ſome diſtance, the gravel or porous under ſoil ſuddenly ceaſes; the clay becomes deeper, and touches the rock or another inferior bed of clay. In this ſituation, the water, unable to deſcend farther, regorges and preſſes upwards upon the clayey ſoil which covers it, rendering it moiſt and ſwampy in every part, and oozing through all its weaker crannies. Thus it forms a belt of moiſt ground along the face of the hill, from which the water perhaps deſcends and damages every part. To drain this declivity, begin at the bottom and carry up a ditch towards the wet ground. As the object is to let out the water at the loweſt point of the reſervoir or natural bag in which it is contained, by making an opening into the gravel there, it will be proper, as the ditch proceeds upwards, frequently to bore holes with an auger of about two inches diameter to a conſiderable depth, that is, about 15 feet, though ſometimes it is neceſſary to go to twice that depth. As long as the water is not found by boring, the ditch muſt be carried upwards, and new auger holes formed; when at laſt the auger by boring reaches the loweſt part of the gravel or reſervoir of water, the water will immediately ruſh forth with conſiderable violence at the hole formed by it, and will continue ever after to run without any danger of choking up. When the bottom of the reſervoir of water or layer of gravel is thus found, another ditch ought to be drawn acroſs the head of the former along the face of the hill, ſo as to form the figure of the letter T. In the upper ditch or drain that runs along the face of the hill, auger holes ought to be bored at ſhort diſtances, to let out the whole water from the interior reſervoir or ſtratum of gravel. The whole proceſs will be eaſily underſtood from conſidering Plate XV. Care ought always to be taken in digging the upper drain along the face of the hill,

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to form it in ſuch a way as that the water may deſcend in it towards the ditch firſt formed, which is intended to convey it down the hill to the neareſt brook. The old practice or mode of draining ground in this ſituation before the uſe of the auger was underſtood, and before men had reflected upon the way in which water is often confined in the earth, conſiſting of digging a trench wherever the ſpouty land commenced. As this was not deep enough to reach the evil, that is, to penetrate to the reſervoir of water, it produced only a partial remedy. Other parallel ditches of the ſame kind were therefore cut the whole way down the declivity, and being filled with looſe ſtones and connected with a deſcending ditch, each carried off only a portion of ſurface water, leaving the ſoil ſtill cold in conſequence of the wetneſs of the bottom.

In performing the operation already deſcribed, ſome difficulties are apt to occur in conſequence of the irregularities with which the ſtrata are often placed in the earth. In boring in the aſcending trench, in the firſt part of the operation, with a view to diſcover the loweſt point at which the water may be let out from the internal reſervoir, the operator is ſometimes apt to be miſled by finding water before he has come high enough to reach the place at which the porous ſtratum ſtops. This ariſes from its ſometimes happening that at the bottom of the reſervoir ſmall leakages occur, and a portion of the water finds its way downwards through crannies in the earth to ſome diſtance from the main reſervoir. When the auger in boring meets theſe leakages, they are apt to be miſtaken for the main body of water, and the operator can only guard himſelf againſt ſuch errors, by forming an eſtimate of the quantity of wa-

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ter which the adjoining high grounds ought to afford. If the quantity of water that follows the auger be very trifling, while the extent of high ground is great, he may be aſſured that he has not yet reached the great cauſe of the wetneſs of the ſoil. It alſo ſometimes happens that the croſs drain carried along the face of the hill, may in ſome places be below the level of the reſervoir of water, while it is upon it at other places. In this caſe, when the auger by boring in the croſs trench brings no water, it will be neceſſary to bore above it, and to conduct the water that is there obtained by a ſmall cut into the general croſs trench.

It ſometimes happens that hills are compoſed of alternate ſtrata, of rock and ſand and clay, which reſt horizontally or nearly ſo upon each other, and penetrate and form the maſs of the hill. In ſuch caſes the ſoil above the ſand or rock is often dry and productive, while the clay is wet and ſwampy. In this caſe, the higheſt part of the hill being generally porous, receives the rain water, which deſcends through it till it meets the impervious clay, which forces it to flow to the ſurface, which it renders wet. Having overflowed the upper clay ſurface, it is immediately abſorbed by the next porous ſtratum; and deſcending into it in like manner, again iſſues at the lower ſide of it, and injures the ſurface of the next bed of clay, as it did that of the firſt. To drain a hill ſide of this deſcription, it is neceſſary to make a trench along the upper ſide of every belt of ruſhy or boggy ſoil to receive the water from the ſuperior porous ſoil, and to lead the whole water thus obtained by one or more ditches downwards to the bottom.

Where a ſoil is compoſed of intermixed varieties, with

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clay predominating, it is ſometimes very difficult to drain, as it is apt to form itſelf into a variety of hollow reſervoirs, each of which holds water like a cup, while, at the ſame time, theſe hollows being full of porous materials, the ſurface of the ſoil is ſufficiently regular. Thus, in wet ſeaſons, patches of moiſt unwholeſome ſoil are formed, not by ſprings for which they may be miſtaken, but by rain water held up by clay in theſe disjoined cavities. They can only be drained by ſeparate covered cuts, communicating in the ſhorteſt way poſſible with one or more main drains.

To drain a bog by letting the water aſcend freely.

With regard to the drainage of bogs, it has already been remarked, that they are either ſuch as can have their water carried off by a communication, at a tolerable expence, with ſome adjoining lower ground; or they are land-locked, ſo as not to admit of being drained in this way. With regard to the former, or thoſe which can be drained by trenches for conducting the water to an adjoining low country or river, they may be rendered wet in two ways: 1ſt, By ſprings oozing out of the adjoining higher ground, in a regular line along the upper ſide of the wet ſurface, which afford water that ſtagnates upon the ſurface of the inferior ground, forming it into a bog. To render free from water a bog of this kind, nothing more is neceſſary than merely to drain the upper adjoining ſwampy ground in the way that has been already ſtated, and to convey away to a diſtance the water produced by it, in regular, open, or hollow drains.—The ſecond claſs of bogs rendered wet by ſprings, conſiſts of thoſe in which the many ſprings that appear are not confined to one regular direction along the upper ſide, but burſt out everywhere, forming ſhaking quagmires, over which it is

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dangerous for cattle to paſs. The upper part of ſuch bogs uſually conſiſts of peat-earth. Below that is found a bed of clay, extremely wet and ſoft, through the crannies of which ſmall quantities of water are continually oozing. When the loweſt part of ſuch a bog is found, or the place in which it will be moſt convenient to convey away the water, little more is uſually neceſſary than to dig proper trenches, and to bore with the auger through the ſtratum of clay to the porous ſtratum containing the water. To drain an extenſive bog, it will uſually be neceſſary to dig a trench from end to end of it, with croſs trenches at conſiderable diſtances, the bottom of the whole being frequently penetrated with the auger, ſo as to allow a free paſſage for the water to aſcend; the effect of which will be, that the nature of the ſurrounding ſoft ſoil will ſpeedily be altered, in conſequence of the water being removed from beneath it. It will become dry and ſolid, and ſoon fit for bearing the plough. The ſame effect would follow although only a ſingle perforation were made through the inferior ſtratum of the bog; and accordingly Mr Elkington is ſaid ſometimes to have ſucceeded, while he drained a bog, in raiſing the water from it conſiderably above its own level, for any purpoſe for which it may be required. This was done by rearing around the perforation, a building of brick, puddled around and within with clay, to the top of which the water roſe, and was from thence conveyed away in pipes or otherwiſe.

Dr Anderſon's rules for draining ſpouty land.

That the whole of this important ſubject, of draining land rendered wet by ſprings, may be better underſtood, we ſhall give an account of it as deſcribed by Dr Anderſon, in his Eſſays publiſhed in 1775, already mentioned. Suppoſing, ſays he, a deſcending ſtratum of ſand or gravel ſhould be diſcontinued, and that the ſtratum above it ſhould be of a coherent clayey nature; in this caſe, the water being pent in on every ſide, and being accumulated in great quantities, muſt at length force a paſſage for itſelf in ſome way, and preſſing ſtrongly upon the upper ſurface, if any one part is weaker than the reſt, it would burſt forth, and form a ſpring; but if the texture of every part of this ſtratum were equally ſtrong, the water would ſqueeze through many ſmall crannies, and would ooze out in numberleſs places, ſo as to occaſion that kind of wetneſs that is known by the name of a ſpouting clayey ſoil.

The cure in this caſe is eaſily effected.—For if a ditch of a conſiderable ſize is opened towards the lowermoſt part of the ſpouting ground, ſo deep as to penetrate through the upper ſtratum of clay, and reach to the gravel, the water will riſe up through it at firſt with very great violence, which will gradually decreaſe as the preſſure from the water behind is diminiſhed; and when the whole of the water accumulated in the ſubterraneous reſervoir is run off, there being no longer any preſſure upon the clay above it, the whole ſoon becomes as dry as could be deſired, and continues ſo ever afterwards, if the ditch is always kept open. This the doctor ſays he can aſſert from experience, having rendered ſome fields of this kind that were very wet quite dry by this method of treating them. The attentive obſerver, he adds, will readily perceive, that if any field that is wet from this cauſe admits of being ploughed, it will be in equal danger of being hurt by being raiſed into higher ridges, with the other kind of damp ground before mentioned. For as the depth of earth above the reſervoir would be ſmaller in the deep furrows than anywhere elſe, there would of conſequence be leſs reſiſtance to the water in that place, ſo that it would ariſe there in greater abundance. And if, in this caſe, a farmer ſhould dig a drain in each furrow, as a conſiderable quantity of water would riſe into them, in ſome caſes the ground might be improved, or even quite drained thereby, eſpecially if they ſhould have accidentally reached the gravel in any one place; although at an expence much greater than was neceſſary. "I take notice of this circumſtance, ſays he, in ſome meaſure to prevent the prejudice that ſome inattentive obſervers might entertain againſt what was ſaid before of this method of draining, from their having accidentally ſeen ſome fields that may have been bettered by it.

"Bogs are only a variety of this laſt-mentioned kind of wet ground; and, therefore, ought in general to be drained after the ſame manner with them. Clay is a ſubſtance that ſtrongly reſiſts the entrance of water into it: but when it is long drenched with it, it is, in proceſs of time, in ſome meaſure diſſolved thereby; loſes its original firmneſs of texture and conſiſtence; and becomes a ſort of ſemi-fluid maſs, which is called a *bog*; and as theſe are ſometimes covered with a ſtrong ſcurf of a particular kind of graſs, with very matted roots, which is ſtrong enough to bear a ſmall weight without breaking, although it yields very much, it is in theſe circumſtances called a *ſwaggle*. But, whatever be the nature of the bog, it is invariably occaſioned by water being forced up through a bed of clay, as juſt now deſcribed, and diſſolving or ſoftening, if you will, a part thereof. I ſay only a part; becauſe whatever may be the

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the depth of the bog or ſwaggle, it generally has a partition of ſolid clay between it and the reſervoir of water under it, from whence it originally proceeds: for if this were not the caſe, and the quantity of water were conſiderable, it would meet with no ſufficient reſiſtance from the bog, and would iſſue through it with violence, and carry the whole ſemi-fluid maſs along with it. But this would more inevitably be the caſe, if there was a cruſt at the bottom of the bog, and if the cruſt ſhould ever be broken, eſpecially if the quantity of water under it were very conſiderable: and as it is probable, that, in many caſes of this ſort, the water ſlowly diſſolves more and more of this under cruſt, I make no doubt but that, in the revolution of many ages, a great many eruptions of this kind may have happened, although they may not have been deemed of importance enough to have the hiſtory of them tranſmitted to poſterity. Of this kind, although formed of a different ſubſtance, I conſider the flow of the Solway moſs in Northumberland to have been; which, upon the 16th of November 1771, burſt its former boundaries, and poured forth a prodigious ſtream of ſemi-fluid matter, which in a ſhort time covered ſeveral hundred acres of very fine arable ground. Nor will any one, who is acquainted with the nature of moſs,—who knows its reſemblance to clay in its quality of abſorbing and retaining water, and its very eaſy diffuſibility therein, be ſurpriſed at this; as from all theſe properties, it is much better adapted for forming an extenſive bog, and therefore in greater danger of producing an extenſive devaſtation by an irruption of the water into it, than thoſe that are formed of any kind of clay whatever.

“ If the bog, or ſwampy ground, is upon a declivity,

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the ditch ought to be carried acroſs the field about the place where the loweſt ſprings ariſe. But if the ſurface of the ground is level or nearly ſo, ſo as to form ſoft quagmires, interſperſed through the whole of the field, it will be of little conſequence in what part the drain is opened; for if it is dug up ſo deep as to allow the water to riſe in it with freedom, it will iſſue through that opening, and the field will be left perfectly dry.

"But as it may frequently happen that the ſtratum of gravel ſhould be at a conſiderable depth beneath the ſurface of the earth, and as it may be ſometimes even below the level of the place into which the drain muſt be emptied, it might ſometimes be extremely difficult to make a ditch ſo deep as to reach the bed of ſand or gravel. But it is lucky for us that this is not abſolutely neceſſary in the preſent caſe; as a drain of two or three feet deep, will be equally effectual with one that ſhould go to the gravel. All that is neceſſary, in this caſe, is to ſink pits in the courſe of the drain, at a moderate diſtance from one another, which go ſo deep as to reach the gravel; for as the water there meets with no reſiſtance, it readily flows out at theſe openings, and is carried off by the drain without being forced up through the earth; ſo that the ground is left entirely dry ever after.

"I have likewiſe drained ſeveral fields in this way: and as I have generally found the appearances pretty much alike, I ſhall, for the information of the inexperienced reader, give a ſhort account of them.

"If you attempt to make your pit in one of theſe ſoft quaggy places where the water is found in great abundance, you will meet with very great difficulty in forming

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forming it; for as the ſubſtance of which it is compoſed is ſoft, it will always flow into the hole as faſt as you dig it; on which account I would adviſe, not to attempt to make the pit in the ſwaggle, but as near it in the ſolid earth as you conveniently can. However, if it is pretty firm, and of no great extent, it is ſometimes practicable to make a pit in the ſoft bog at the drieſt time of the year. This I have ſometimes practiſed, which gave me an opportunity of obſerving the nature of theſe bogs more perfectly than I otherwiſe would have had. In the trials of this kind that I have made, this ſoft quaggy ground has ſeldom been above three or four feet deep; below which I have always found a ſtratum of hard tough clay uſually mixed with ſtones, and ſo firm that nothing but a mattock or pick-axe could penetrate it: and as this is comparatively ſo much drier than the ground above it, an inexperienced operator is very apt to imagine that this is the bottom that he is in ſearch of. In digging through this ſtratum, you will frequently meet with ſmall ſprings oozing out in all directions; ſome of them that might fill the tube of a ſmall quill, and others ſo ſmall as to be ſcarce perceptible: but without regarding theſe, you muſt continue to dig on without intermiſſion till you come to the main body of the reſervoir, if I may ſo call it, that is contained in the rock, gravel, or ſand; which you will generally find from two to four feet below the bottom of the ſwaggle, and which you will be in no danger of miſtaking when you come to it: for, if there has been no opening made before that in the field, as ſoon as you break the cruſt immediately above the gravel or rock, the water burſts forth like a torrent, and on ſome occaſions riſes like a *jet d'eau*, to a conſiderable height above the

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the bottom of the ditch; and continues to flow off with great impetuoſity for ſome time, till the pent-up water being drained off, the violent boiling up begins to ſubſide, and the ſtrength of the current to abate; and, in a ſhort time, it flows gently out like any ordinary ſpring; —allowing it to remain in this ſtate, the quaggy earth begins to ſubſide, and gradually becomes firmer and firmer every day; ſo that, in the ſpace of a few months, thoſe bogs which were formerly ſo ſoft as hardly to ſupport the weight of a ſmall dog, become ſo firm that oxen and horſes may tread upon them without any danger of ſinking, at the very wetteſt ſeaſon of the year. I have had a field of this nature, that, by having only one ſuch pit as I have now deſcribed opened in it, was entirely drained to the diſtance of above a hundred yards around it in every direction. But as it is poſſible that the ſtratum in which the water runs may be in ſome places interrupted, it will be in general expedient to make ſeveral of theſe pits, if the field is of great extent; always carrying the drain forward through the lowermoſt part of the field, or as near the quag as you conveniently can; and ſinking a pit wherever you may judge it will be moſt neceſſary. But if the ſtratum of gravel is not interrupted, there will be no violent burſt of water at opening any of theſe after the firſt, as I have frequently experienced. To keep theſe wells from cloſing up after they are made, it is always expedient to fill them up with ſmall ſtones immediately after they are made, which ought to riſe to the height of the bottom of the drain.

" I have often imagined that the expence of digging theſe pits might be ſaved by boring a hole through this ſolid ſtratum of clay with a large wimble made on

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on purpoſe; but as I never experienced this, I cannot ſay whether or not it would anſwer the deſired end exactly.

" If the whole field that is to be drained conſiſts of one extenſive bog, it will require a long time before the whole work can be entirely finiſhed, as it will be impoſſible to open a drain through it till one part of it is firſt drained and become ſolid ground. In a ſituation of this kind, the undertaker, after having opened a drain to convey the water from the loweſt part of the bog, muſt approach as near to the ſwampy ground as he can, and there make his firſt pit; which will drain off the water from the neareſt parts of the bog. When this has continued open for ſome time, and that part of the bog is become ſo ſolid as to admit of being worked, let him continue the ditch as far forward through it as the ſituation it is in will admit of, and there ſink another pit; and proceed gradually forward in the ſame manner; making croſs cuts where neceſſary, till the whole be finiſhed.

" In this manner may any bog or tract of ſpouting ground of this nature be rendered dry at a very inconſiderable expence; and as there can be no other method of draining ground of this ſort effectually, I recommend the ſtudy of it to the attention of every diligent farmer who may have occaſion for it. Let him firſt be extremely cautious in examining all the circumſtances of his particular fields, that he may be certain which of the claſſes above enumerated it may be ranked with; and when he is perfectly ſure of that, he may proceed without fear, being morally certain of ſucceſs.

We ſhall add the ſubſtance of a paper on this ſubject,

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MrWedge's mode of draining.

jeſt, for which the author received the ſilver medal of the Society inſtituted for the encouragement of Arts, Manufactures, and Commerce. That author is Mr John Wedge of Bickenhill, near Coventry, who is not only a great farmer himſelf, but had likewiſe been employed by the earl of Aylesford in the management of ſeveral eſtates. Encouraged by his lordſhip's liberality, Mr Wedge informs the ſociety, that he had been employed for ſome years in draining large portions of land, of which part was in the earl's occupation, and part in his own, as tenant to his lordſhip. The principles upon which he proceeded, as well as his mode of procedure, he ſtates in the following terms:

In every country there are large portions of land that, in wet ſeaſons, have always what may be called a *dry ſurface*, and other portions of land that have always a *moiſt* or *wet ſurface*; the former of theſe admitting all the water which falls upon them to ſink freely through their pores to various depths, till falling on clay, or ſome other unctuous earth, whoſe pores will not permit it to paſs through, it is there held up to a height proportioned to the quantity of water which comes upon it, and the facility with which that water is diſcharged. Thus, held up to various heights, it ſerves as a fountain to diſtribute its water (either by veins of ſand, pebbles, or rock, according to the formation of the different under ſtrata) on the neighbouring lands; and there forms bogs and other varieties of wet ſurface, on a baſis that will be always found to conſiſt of marl or clay, or ſome mixture thereof. The effect of water thus diſtributed may be divided into two claſſes. The firſt claſs, where the water is thrown out by a body of marl or clay, &c. upon the ſurface of deſcending

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ing ground, and in the valley (there held up by clay alſo) forms bogs or ſwamps. The ſecond claſs, where the water is held up by marl or clay, as before, having above that marl or clay a ſtratum of ſand, or pebbles, through which the water paſſes; and above thoſe ſands or pebbles another ſtratum of marl or clay, through the weakeſt parts of which the water, by a continual preſſure from its fountain, forces a paſſage upwards; and thus, through the weakeſt parts of the marl or clay, furniſhes a continual ſupply of water on the ſurface, for the formation or growth of bogs, &c. in proportion as this water is more or leſs abundantly ſupplied by its fountain or head, namely, the higher lands, into which rain-water freely paſſes, as before deſcribed. There are alſo different ſoils, under different circumſtances, which may form a third claſs of land for draining; ſuch as ſtrong deep ſoils, or open light ſoils, having near the ſurface a body of marl or clay. In either of theſe caſes, the water which falls on the ſurface muſt for reaſons which are ſelf-evident, keep ſuch lands, in rainy ſeaſons, conſtantly wet and cold; and it ſhould be obſerved, that a mixture of all the three before-deſcribed claſſes of wet land ſometimes occurs in one field, by ſudden alterations of the under ſtrata, and thereby perplexes the operator, by requiring all the different modes of draining in the ſame field.

If it be admitted that bogs are thus formed and fed, their cure may be effected with certainty: The firſt claſs, by cutting through the ſtratum (be it ſand, pebbles, or rock), that conveys the water to the bog, and carrying off that water by a cloſe drain to ſome proper place, where the level admits of its diſcharge: The ſecond claſs, by ſinking a drain to any convenient depth in the upper clay; and then digging or boring with a large auger, at a ſmall diſtance on one ſide of this drain, through the remaining part, be it (the upper clay) ever ſo deep, into the under ſtratum of ſand, pebbles, or rock, through which the water paſſes; which will then ruſh up into the drain ſo made, with a velocity proportioned to the height of the land or fountain whence it is ſupplied. As this drain advances through the land, holes muſt be dug or bored, as before, every ſeven yards, or at ſuch diſtance as the ſtrength of the ſprings may require; and the whole of the water thus brought up by tapping the ſprings, is carried off by the drain made in the upper clay, which muſt be a cloſe one, to its proper level, and there diſcharged.

By both theſe methods of draining, large tracts of land, under favourable circumſtances, may be cured with one drain. The beſt place for fixing theſe drains is where the ſtratum that conveys the water comes neareſt to the ſurface;. and the beſt method of aſcertaining that, is to bore or dig in different parts through the different under ſtrata.

The third claſs may be eaſily cured by cloſe drains, at ſuch diſtances and depths as will beſt carry off the ſurface-water. It may not be improper to obſerve, that where the different ſtrata or meaſures crop out, that is, become gradually more and more ſhallow in ſome certain direction (as is often the caſe, till, one after the other, they all preſent themſelves in ſucceſſion on the ſurface of the earth), draining may often be much more eaſily and better effected by croſſing with the drain the different ſtrata or meaſures, where the levels and other circumſtances will admit.

Some of the land drained was part of a common, in

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the pariſh of Church Bickenhill, in the county of Warwick; part of it was covered with moſs and ling, had a peaty ſurface, about ſix inches deep, and produced little or no graſs: in all wet ſeaſons it was filled quite to the ſurface, and often overflowed, with water. Some of the land was much more unſound, deeper of peat, and covered with moſs, in moſt parts nine inches long; another part was an abſolute bog in all ſeaſons.

Having dug or bored with a large auger into ſeveral parts of the land, Mr Wedge found peat, gravel, and ſand mixed, and a quickſand almoſt uniformly. The quickſand in every part, after getting an inch or two into it, ſeemed almoſt as fluid as water. Judging from this, that no materials for a drain could be laid in the quickſand, but what it would immediately bury, he dug a trench almoſt to the quickſand, leaving gravel, &c. of ſufficient ſtrength to bear up the materials for a hollow drain; theſe materials were two ſides and a coverer of ſtone, with a peat-turf on the top to keep out the ſoil. At every ſeven yards forward, by the ſide of this drain, he dug a hole in the quickſand as deep as it would permit. From theſe holes the water roſe freely into the hollow drain, and was by it diſcharged at a proper level. It may be proper to remark, that the ſtone made uſe of for this drain, and all others here mentioned, was a red ſand and rag-ſtone, which eaſily ſplit into proper ſizes for the purpoſe, and is very durable; it coſt about ſixpence per ton getting, excluſive of carriage. The drain thus formed ran on the whole rather freely, and made the land dry for a few yards on each ſide thereof, but was far from having the effect he improperly expected; for it evidently appears that the drain could only take a very ſmall portion of the water from ſo large a quickſand, which it did not penetrate more than two inches; and that it could drain only to its own depth, or, at moſt, to that depth in the fountain which ſupplied the quickſand. His purpoſe was then defeated; and his motive for mentioning this error cannot, he hopes, be miſtaken.

He now did what he ſays he ought to have done before, that is, he examined the different ſtrata to a greater depth, particularly on the bog, and at the upper edges thereof, and found the bog to be what has been deſcribed under the firſt claſs. He therefore determined to attempt the cure in the manner before preſcribed for that claſs, namely, to cut through the whole of the ſtratum (in this inſtance, of quickſand), through which he found the water paſs. This he effected as follows: The ſummer being dry, and favourable for the purpoſe, and having previouſly made his main open drain, he began his main cloſe drain the firſt week in June 1791, three feet wide, on the declivity near the edge of the great bog. In the firſt operation he dug through the peat, the hard ſand, and gravel, and one ſpade's graft (about nine inches deep, and ſeven inches wide) into the quickſand the whole length of this drain, which was 73 perches, of eight yards to the perch, in length. The drain thus dug ran copiouſly, not leſs than 60 gallons per minute. In this ſtate he left it about nine days: the effect of it was rapid, both above the drain and on the bog below. Upon examination, he now found about three inches on the top of the ſpade's graft, which had been made into the quickſand, perfectly dry. He then dug out theſe three inches of dry ſand, to nearly the whole width of the drain, three feet; and at the ſame time dug out, as before, another ſpade's graft,

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from the top of the quickſand, as near the middle of the drain as poſſible. This was left to run a few days, as before, and had the ſame effect; namely, three or four inches more of the top of the quickſand became dry and hard. The ſame operation was repeated again and again with the ſame effect, till the purpoſe of getting through this quickſand was completed, ſo far at leaſt as the level of the main open drain would permit. The ſtream of water continued increaſing during the whole operation; the bog below the drain was quite dry, and the land above perfectly ſo. The drain which was firſt made, and continued running for ſome time during the progreſs of the main cloſe drain, became gradually dry; and has not, ſince that drain was finiſhed, diſcharged one ſingle drop of water. Great care was neceſſary, in making the main cloſe drain, to keep the ſtream of water in the middle of it, otherwiſe the current would have undermined the ſides, as it ſometimes had done, and cauſed them to fall in. For this reaſon it was neceſſary, when the dry ſand was taken from the top of the quickſand, immediately to take out a ſpade's graft from the middle thereof, in order to divert the current from the ſides.

The main cloſe drain thus made was three feet wide at top, about nine feet deep on the average, and, bevelling a little from the top, it was about one foot ten inches wide at the bottom. The ſtone and other materials were put into this drain in the following manner: 1. Where the drain went through the quickſand into the ſtratum of clay below it, as in moſt places it did, the bottom, and in ſome inſtances the ſides, wanted no particular ſecurity; but where it did not go quite through the quickſand, which the level of his main open drain in ſome places would not admit, the bottom of the drain was covered half an inch thick with ling; then peat turfs, one foot wide and three or four inches thick, were cut in convenient lengths, and placed on their edges on each ſide of the bottom of the drain, forming two ſides of a trough of peat; then ſide ſtones about eight inches high, and a ſtone coverer, were put in upon the ling between the peat turfs; a large peat turf, near two feet wide and four inches thick, was then cut and firmly placed over the whole: this left in the bottom of the drain an open ſpace, of more than ſix inches ſquare, for the water to paſs. The whole was then completed by filling in the upper part of the drain.

In this way Mr Wedge drained for about 80l. thirty acres of land, which from being of no value whatever, became worth at leaſt 14 ſhillings per acre of yearly rent. He likewiſe hollow-drained nine acres by the method preſcribed for the third claſs of wet land. Theſe drains were made a few yards below that part of each field where the dry and wet land ſeparate, about 22 inches deep, with ſides and a coverer of ſtone, and ling on the top of it, to keep the earth from running in. The length of theſe drains was 880 yards, and the expence of labour and materials three halfpence per yard. The drains, in wet weather, diſcharge a large quantity of water; and will, he has no doubt, anſwer the intended purpoſe. Thus far relates to land in his own occupation.

Nine acres of the land in the earl of Aylesford's occupation was almoſt an entire pulp. This bog was of the ſecond claſs, namely, water paſſing through a quickſand, and confined by a ſtratum of clay below, and another ſtratum of clay above it. The water thus confined, being preſſed by its fountain, and forced up through the weakeſt parts of the clay, had formed a bog of irregular thickneſs on the ſurface, in ſome places ſix feet deep, in others not more than two. As there is a conſiderable fall in this land from eaſt to weſt, he thought it expedient to put two drains into it; and this appears to him to have been neceſſary, from a conſideration that both theſe drains continue to run in the ſame proportions as when firſt opened. The manner in which theſe drains were executed was, by digging through the different upper ſtrata, and as deep into the clay as the main open drain would admit; then digging or boring through the remaining part of that clay into the quickſand, at the diſtance of about ſix yards, in a progreſſive manner.

The water riſing rapidly through theſe holes into the cloſe drains, has effected a complete cure of this land, every part of which will now bear a horſe to gallop upon it. Theſe drains diſcharge 3660 gallons an hour; which is much leſs than they did at firſt, as muſt be the caſe in all bogs. This land will be worth 20s. per acre. The draining coſt 25l.; and the length of the under-ground drains is eight hundred and fourteen yards.

Mr Wedge had juſt finiſhed (January 1792) draining another piece of land, about forty-three acres. As this was intended to anſwer two purpoſes, one, to drain the land, the other to give an additional ſupply of water to a mill-pool, and as a circumſtance aroſe in the execution of the work which frequently happens in draining land, namely, a ſudden alteration in the poſition of the under ſtrata; a deſcription thereof will not probably be thought tedious. This draining was begun at the level of a mill-pool, and continued, without any great difficulty, to the diſtance of about thirty-two chains, in the manner before deſcribed as a cure for the ſecond claſs of boggy land: but at or near that place the under ſtrata altered their poſition; the quickſand which conveyed the water now became of twice its former thickneſs; and the clay, which had hitherto been above that quickſand, for ſome diſtance diſappeared. From the quickſand thus becoming ſo much deeper, he could not, with the level of the mill-pool, cut through it; nor indeed, from the wetneſs of the ſeaſon, would ſuch an operation have been proper. He therefore continued a ſhallow drain to ſome diſtance, making ſide-holes into the quickſand, which ran freely; but as this could not cure the whole of the bog below, he branched out another drain (which was made by the method deſcribed for curing the ſecond claſs of wet or boggy land), by ſinking a cloſe drain through the upper ſtrata into the upper clay, and then, at a ſmall diſtance on one ſide of this cloſe drain, boring a hole with an auger through the remaining part of that clay into the quickſand; and at every eight yards, as this cloſe drain advanced, ſtill boring other holes, in the manner before deſcribed: through many of theſe holes the water ruſhed with great rapidity. The water diſcharged by theſe drains into the mill-pool is 168 gallons per minute, or 3780 hogſheads in a day; which is after the rate of 1,379,700 hogſheads in a year.

About ſix acres of this land were always ſound; about twelve acres on the north ſide were an abſolute pulp, and the remaining twenty-ſix acres very unſound. The whole is now ſound, and will when cultivated be worth

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worth 16s. per acre. This land would have been drained at a much leſs expence into the main open drain; but then the water, which was much wanted for the mill, would have been loſt. Theſe cloſe drains are in length 1452 yards, and coſt 100l. of which about 30l. ought to be charged to the mill.

§ 3. *Of Draining Land-locked Bogs or Lands, where a declivity cannot be obtained to carry off the water.*

Draining of land-locked bogs.

With regard to the drainage of land-locked bogs, which are often ſituated ſo much lower than the ground around them, that the cutting a main drain would coſt more than the value of the land when drained; the mode of proceeding, with a view at once cheaply and effectually to relieve them from the ſuperfluous moiſture which renders them uſeleſs to agriculture, is the following: A ſpot in the middle or loweſt part of the bog muſt be ſelected, towards which all the drains muſt be conducted, as radii to a common centre. When this central is ſpot is properly cleared out to the top of the clay, or retentive ſubſtratum, which in this caſe muſt not be affected by water from below, but only by ſurface or rain water, a number of perforations muſt be made with the auger, to give an outlet downwards for the water, which will be abſorbed by the porous ſtratum below. A conduit ſhould be formed over the auger holes, by looſe ſtones, placed in ſuch a manner as to prevent their being afterwards filled up by any rubbiſh: or rather auger holes may not be ſufficient; and it may be a preferable plan to make a large pit, or well, in the loweſt part of the bog, dug through into the porous ſubſtrata. This pit ought to be filled with large ſtones, and the drains from the reſt of the field

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[illegible] conducted to that ſpot, as mentioned in the following quotation from the Agricultural Report of Hertfordſhire.—" If a pit is ſunk 20 or 30 feet deep in the middle of a field, through the Hertfordſhire red, flinty, and impervious clay, into the chalk below; when the uſual quantity of chalk is taken out, the pit ſhaft is filled up with the flint taken out of the chalk and clay, and the top drainage of this part of the field is much ſhortened for ever afterwards, by making principal drains from the part of the field above the level of the top of the pit terminate therein, as the ſuperabundant moiſture will eſcape through the flints in the pit ſhaft to the chalk below. And if a drain is carried into a limeſtone quarry, it is ſeldom neceſſary to carry it further.

" In dells or hollows, of conſiderable extent, covered with an impervious ſtratum, and from which there is no natural drainage, ſuch as the valley between Mold, the ſhire-town of Flintſhire, and the adjoining high land, a pit about four feet diameter, and 15 feet deep, more or leſs, as the caſe may require, is ſunk through the impervious ſuperſtratum, into a pervious ſtratum of gravel, and the rain water, and that of ſome adjoining ſprings, are carried from the ſurface thereby; the pit is railed round to prevent cattle from falling into it. I muſt here remark, that though in this, as well as in many other inſtances that may be given, the top water eſcaped through the pervious ſubſtratum, the effect might have been directly the contrary. I therefore recommend the impervious ſuperſtratum, in all ſuch caſes, to be perforated by bore-rods, as the hole made by them is eaſily ſtopped up."

In Dr Nugent's travels through Germany, publiſhed

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German mode of draining land-locked bogs.

in 1768, a mode of draining marſhes upon ſimilar principles is deſcribed, as having been practiſed in that country. He had only ſeen it performed on moor grounds, though it is alſo ſucceſsful with regard to lakes. "It is the nature, ſays he, of moors in general, that beneath the turf or moſs there is a loam which hinders the moiſture from penetrating; and this indeed is what makes the marſh, and cauſes the luxuriant growth of the turf or moſs: but this loam or clay is only a ſtratum, and far from being of an immenſe depth; under it is generally a ſand, or ſome other ſtony or looſe ſoil.

"Here reaſon readily informs us, that a middling moraſs may be drained by perforating the clay, and thus making way for the moiſture to penetrate. In order to this, a pit is dug in the deepeſt part of the moor, till they come below the obſtructing clay, and meet with ſuch a ſpongy ſtratum as, in all appearance, will be ſufficient to imbibe the moiſture of the marſh above it. Into this pit the ebbing of the moraſs is conveyed through a trench, and both the trench and the pit are filled up after the firſt drain with large broad ſtones, ſetting them edgewiſe, ſo as to leave interſtices for carrying off the water; then ſuch ſtones are laid over breadthwiſe, and theſe covered with looſe earth like that on the ſurface: when no ſuch ſtones are to be had, ſtrong piles are rammed down the ſides of the trench, and broad boards laid acroſs; and theſe are covered with earth to a height fit for culture. This is a matter of no great expence, the pit being as near the moraſs as the water will admit, and the trenches but ſhort; then they have a drain unperceived, which leaves the ſurface of the trenches for the plough: and in

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ſtanding marſhes, eſpecially in ſuch moors as are only wet and damp, this method, though ſometimes ſlow, never fails taking effect; and many tracts are thereby made ſerviceable to the farmer or grazier."

Draining in Roxburghſhire.

The writer of the Roxburghſhire Agricultural Report repreſents himſelf as having ſucceſsfully adopted a ſimilar mode of draining. In that part of the country, ſuch of the waſte lands, as are capable of being drained ſo as to become arable, have, at the diſtance of from one to ſix feet below the ſurface, a large ſtratum or ſeam of a black ſlaty or metallic ſubſtance, generally from 20 to 25 feet in thickneſs. Below this is a layer of whinſtone rock of unknown depth. The black ſlaty or metallic ſubſtance has no chinks or fiſſures, and is impenetrable to water; but the whinſtone rock beneath it abounds with chinks and fiſſures, and will ſwallow up any quantity of water poured into its boſom. The uppermoſt ſurface of the ſoil is of a light moſſy nature, upon which the water ſtagnates in winter, ſo as to ſwell and enlarge it to a conſiderable degree. In the ſpring months, when dried by the ſun and the wind, the moſs becomes tolerably firm, and produces a coarſe unprofitable graſs, mixed with ſhort heather; neither of which are of any value as food for ſheep or cattle. In the year 1784 the writer of the Report ploughed up 20 acres of the waſte lands of the above deſcription, a part of them being ſituated on a level. This laſt part was gathered in ſmall ridges, and ploughed pretty deep, and the ſtones removed. Thus it lay till midſummer 1785; but, during the ſpring, the ſheep and cattle were frequently driven upon it to tread it to a firm conſiſtence. At midſummer it was gathered up again; and, to get the water out of the hollows of the ridges,

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a pair of boring rods were obtained, which were ſ..t down through the ſlaty ſubſtance to the whinſtone rock at ſundry places. This effectually anſwered the purpoſe. The tops of the holes were kept open with baſkets of looſe ſtones over them, which were allowed to remain or removed at pleaſure, as the weather proved more or leſs wet. In ſpring 1786 the land was in condition to be ſown almoſt as early as any other part of the farm, the winter rains having found their way down into the whinſtone rock through the ſlaty ſubſtance. The land ſpeedily became and continued very valuable.

Draining of quarries and mines.

We may here add, that the modes of draining now ſtated are alſo valuable for other purpoſes than thoſe of agriculture. Quarries, for example, and marl pits may often be cleared of water, by cutting off the ſprings by which they are incommoded, or by letting down the water into the next porous ſtratum. The ſame may be often done, with regard to deep mines, the working of which may frequently be thus greatly facilitated. A colliery, for example, in Yorkſhire had been wrought for ſeveral years, and the water was raiſed from it about 60 yards by a ſteam engine. The proprietors having bored about ten yards farther, to aſcertain the thickneſs of a ſeam of coals; as ſoon as the boring rods were withdrawn, the water from the works, which uſually ran acroſs that place, began to ſink into the holes made by the rods; and, continuing to do ſo, the ſteam engine became uſeleſs, as its pump had no longer any water to draw. It muſt be obſerved, that the ſituation was higher than the neareſt valleys, or the level of the ſea; but this example ſhows of what extenſive importance a knowledge of the principles upon which

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the above modes of draining proceed may hereafter become.

3. *Of rendering Moſſes fit for Cultivation.*

In many parts of the country a very ſerious obſtruction to the cultivation of large portions of territory ariſes from the exiſtence of moſſes. It is, therefore, of much importance to conſider their nature, and how they are to be rendered fertile.

Nature and origin of moſſes.

With regard to the nature and origin of moſs, the celebrated Dr Anderſon, whoſe works we have already frequently quoted, advances this opinion, that moſs is a vegetable, or an aſſemblage of vegetables, growing or living below, while at the top it is dead. Hence, he diſtinguiſhes moſs into two kinds; quick moſs, from which peats are dug, on which no vegetables grow, and in which no animals exiſt, while in its natural ſituation; and dead moſs, which frequently covers the former, and upon which heath and fog and coarſe graſſes grow, and inſects and other animals are found. Mr Headrick* ſtates various objections to this opinion, ſome of which appear to have great force. Thus, it is obſerved, that the moſs here ſuppoſed to be alive below the ſoil, has every mark of utter deadneſs and partial diſſolution. When toſſed about in a very dark night, it emits light like half-rotten wood, giving riſe to frequent terrors in thoſe who live in the vicinity of peat bogs. It alſo ſeems a ſtrange circumſtance, and contrary to the whole analogy of nature, to ſuppoſe that a vegetable ſhould grow, ſhould form ligneous fibres, and acquire

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* *Communications of the Board of Agriculture*, vol. ii.

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acquire inflammability, without the influence of the ſun, or contact with the air, during any period of its growth. The true hiſtory of the origin of moſſes ſeems to be this: What are called the moſs plants, amount to about three hundred in number. They are extremely hardy, and are capable of flouriſhing in the moſt cold and bleak ſituations, providing only they are ſurrounded by abundance of ſtagnating water. Accordingly, wherever water ſtagnates in a moderate quantity, they grow up, and, by ſpreading themſelves around, they increaſe the ſtagnation. When they have ariſen in this manner, with the water around them, to a conſiderable height, the lower part of their ſtems being continually ſoaked or macerated in water, ceaſe to vegetate, and give forth their juices to the ſurrounding fluid. As the moſs plants are extremely aſtringent, and contain large quantities of the gallic acid and tanning principle, the moſs water acquires theſe qualities, or becomes aſtringent, in a great degree, and prevents any proceſs of putrefaction from taking place, or the ſtems of the moſs plants from ſuffering any proper proceſs of rottenneſs, or chemical decompoſition. Hence it is, that moſs water has ſometimes been uſed for tanning leather, in the ſame manner as the liquor of oak bark. In the mean time, while the ſtems of the moſs plants remain in this manner dead, but prevented from rotting, or becoming the habitation of animals which cannot live in a vegetable aſtringent liquor, the tops of the plants that are at the ſurface of the water continue to grow, or new plants riſe upon the ſummits of the dead ones, and continue their aſcending progreſs; the whole being perhaps a ſort of paraſitical plants, which can grow upon each other.

In this way, a moſs proceeds, riſing higher and higher, till

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till from the nature of the adjoining country, and the declivities in it, the water cannot ſtagnate to any greater depth. After the moſs has come to this height, its farther growth is prevented: its plants, unable to live or grow without abundance of water, wither and die; the upper part of them being expoſed to the action of the air, ſuffers an ordinary proceſs of decompoſition, like other vegetable remains, and is converted into a ſort of ſoil, upon which a few plants and reptiles are ſometimes found; while at a ſmall depth, that is to ſay, below the ſurface of the ſtagnating water, the whole ſtems of the ancient moſs plants continue macerated in their own liquor, and preſerved from putrefaction by it.

Black and yellow moſs.

There are, however, two general kinds of moſſes; black moſs, and whitiſh or yellow moſs. The black moſs is originally of a mahogany colour, but ſpeedily becomes black upon expoſure to the air. The yellowiſh, or foggy moſs, is much leſs compact than the former, and retains a light or yellowiſh colour after it is dried. It does not appear to be in ſuch a perfect ſtate of maceration as the black moſs, has leſs variety of plants, and is never ſo ſolid. It is uſually produced in low warm ſituations, and appears to have grown rapidly; whereas, the black moſs is moſt commonly found in cold elevated lands, and ſeems to have conſiſted of a greater number of leſs luxuriant plants. Thus, moſs may be regarded as bearing ſome reſemblance to timber, which is always of a compact grain, and cloſe texture, in proportion to the ſeverity of the climate of which it is the product, or rather in proportion to the length of time which it has taken to grow.

From what has been here ſtated, it will not be diffi-

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cult to underſtand the mode in which moſſes come originally to find an exiſtence, or to cover a piece of territory in any country. When a pool of water is ſpeedily, or in a ſhort time, formed to a great depth, no moſs appears; but when a gradual ſtagnation, to a ſmall depth takes place, upon any ſpot, eſpecially in a cold and expoſed ſituation, there the moſs plants (being the only ones capable of ſubſiſting on ſuch a ſoil) ſpeedily grow up, and occupy the place of every other. Though the quantity of water that originally ſtagnated there might not be great, it is increaſed by degrees, in conſequence of the additional obſtruction produced by the roots, ſtems, and leaves of the moſs plants, till at laſt it forms a bog of very great depth.—We have already mentioned the nature and cauſes of the ſtagnation of water. It may either occur in conſequence of the figure and quality of the ſoil making it tenaciouſly to retain the falling rains, or it may be the conſequence of ſprings or reſervoirs of water pent up or confined in the bowels of the earth by an incumbent maſs of clay. Struggling to riſe up through this clay, it will wet every part of it, and will ſlowly ooze through all its leſs adheſive parts, and will form a ſoil fit only for the reception of moſs plants, which will there, by obſtructing the departure of the moiſture, which is conſtantly riſing, in the courſe of years rear up the ſurface into a complete and perfect peat-bog.

Moſſes produced by cutting down foreſts.

But moſſes not only ariſe in particular ſituations, in conſequence of theſe operations of nature; they are alſo produced as the reſult of certain exertions of human induſtry. In almoſt all our moſſes in this country great numbers of trees of various ſorts are found. They remain, like the inferior parts or roots of moſs plants, infuſed

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fuſed and macerated in the moſs water, but not rotted. The trees and ſhrubs found at the bottom of moſſes in Scotland, exhibit, perhaps, the whole variety of the native trees and ſhrubs. Of trees, are found the oak, the elm, the birch, the willow, the alder, and the fir. Of ſhrubs, we find the hazel, the dwarf willow, the gall plant, and laſtly, the heath plant. This laſt is of ſo hardy a nature, that it often continues to riſe upon the moſs during the whole period of its exiſtence. Now, if it ſhould be ſuppoſed, that at any time extenſive foreſts of theſe trees were ſuddenly cut down by the exertions of man, they would undoubtedly produce a ſtagnation of water, and a bleakneſs of climate, that would render the ſituation fit only to be inhabited by moſs plants, which would, therefore, ſpeedily riſe up, and form a peat-bog, in which multitudes of trees and ſhrubs would be found ſoaked in their own juice, and in the aſtringent liquor reſulting from the maceration of the ſtems of the moſs plants. That in ancient times old foreſts were thus deſtroyed by the efforts of man, we have every reaſon to believe. Not only in this country, but alſo in England and Ireland, there are found in moſſes vaſt numbers of trees ſtanding with their ſtumps erect, and their roots piercing the ground in a natural poſture as when growing. Many of thoſe trees are broken or cut off near the roots, and lie along, and this uſually in a north-eaſt direction. People who have been willing to account for this, have uſually reſolved it into the effect of the deluge in the days of Noah; but this is a very wild conjecture, and is proved falſe by many unanſwerable arguments. The waters of this deluge might indeed have waſhed together a great number of trees, and buried them under loads of earth;

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but then they would have lain irregularly and at random: whereas, in this caſe, the trees all lie lengthwiſe from ſouth-weſt to north-eaſt, and the roots all ſtand in their natural perpendicular poſture, as cloſe as the roots of trees in a foreſt.

Beſides, theſe trees are not all in their natural ſtate, but many of them have the evident marks of human workmanſhip upon them, ſome being cut down with an axe; ſome ſplit, and the wedges ſtill remaining in them; ſome burnt in different parts, and ſome bored through with holes. Theſe things are alſo proved to be of a later date than the deluge, by other matters found among them, ſuch as utenſils of ancient people, and coins of the Roman emperors.

It appears from the whole, that all the trees which we find in this foſſil ſtate, originally grew in the very places where we now find them, and have only been thrown down and buried there, not brought from elſewhere. It may appear indeed an objection to this opinion, that moſt of theſe foſſil trees are of the fir kind; and that Cæſar ſays expreſsly, that no firs grew in Britain in his time: but this is eaſily anſwered by obſerving that theſe trees, though of the fir kind, yet are not the ſpecies uſually called the *fir*, but pitch tree; and Cæſar has nowhere ſaid that pitch trees did not grow in England. Norway and Sweden yet abound with theſe trees; and there are at this time whole foreſts of them in many parts of Scotland, and a large number of them wild upon a hill at Wareton in Staffordſhire to this day.

In Hatfield marſh, where ſuch vaſt numbers of the foſſil trees are now found, there has evidently once been a whole foreſt of them growing. The laſt of theſe was found alive, and growing in that place, within 70 years laſt paſt, and cut down for ſome common uſe.

It is alſo objected by ſome to the ſyſtem of the firs growing where they are found foſſil, that theſe countries are all bogs and moors, whereas theſe ſorts of trees grow only in mountainous places. But this is founded on an error; for though in Norway and Sweden, and ſome other cold countries, the fir kinds all grow upon barren and dry rocky mountains, yet in warmer places they are found to thrive as well on wet plains. Such are found plentifully in Pomerania, Livonia, Courland, &c.; and in the weſt parts of New England there are vaſt numbers of fine ſtately trees of them in low grounds. The whole truth ſeems to be, that theſe trees love a ſandy ſoil; and ſuch as is found at the bottoms of all the moſſes where theſe trees are found foſſil. The roots of the fir kind are always found fixed in theſe; and thoſe of oaks, where they are found foſſil in this manner, are uſually found fixed in clay; ſo that each kind of tree is always found rooted in the places where they ſtand in their proper ſoil; and there is no doubt to be made but that they originally grew there. When we have thus found that all the foſſil trees we meet with once grew in the places where they are now buried, it is plain that in theſe places there were once noble foreſts, which have been deſtroyed at ſome time; and the queſtion only remains how and by whom they were deſtroyed. This we have reaſon to believe, by the Roman coins found among them, was done by the people of that empire, and that at the time when they were eſtabliſhed or eſtabliſhing themſelves here.

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Their own hiſtorian tells us, that when their armies purſued the wild Britons, theſe people always ſheltered themſelves in the miry woods and low watery foreſts. Cæſar expreſsly ſays this; and obſerves, that Caſſibelan and his Britons, after their defeat, paſſed the Thames, and fled into ſuch low moraſſes and woods that there was no purſuing them: and we find that the Silures ſecured themſelves in the ſame manner when attacked by Oſtorius and Agricola. The ſame thing is recorded of Venutius king of the Brigantes, who fled to ſecure himſelf into the boggy foreſts of the midland part of this kingdom: and Herodian expreſsly ſays, that in the time of the Romans puſhing their conqueſts in theſe iſlands, it was the cuſtom of the Britons to ſecure themſelves in the thick foreſts which grew in their boggy and wet places, and when opportunity offered, to iſſue out thence and fall upon the Romans. The conſequence of all this was the deſtroying all theſe foreſts; the Romans finding themſelves ſo plagued with parties of the natives iſſuing out upon them at times from the foreſts, that they gave orders for the cutting down and deſtroying all the foreſts in Britain which grew on boggy and wet grounds. Theſe orders were punctually executed; and to this it is owing that at this day we can hardly be brought to believe that ſuch foreſts ever grew with us as are now found buried.

The Roman hiſtories all join in telling us, that when Suetonius Paulinus conquered Angleſea, he ordered all the woods to be cut down there, in the manner of the Roman generals in England: and Galen tells us, that the Romans, after their conqueſt, kept their ſoldiers in Britain conſtantly employed in cutting down foreſts, draining

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draining of marſhes, and paving of bogs. Not only the Roman ſoldiers were employed in this manner, but all the native Britons made captives in the wars were obliged to aſſiſt in it: and Dion Caſſius tells us, that the emperor Severus loſt no leſs than 50,000 men in a few years time in cutting down the woods and draining the bogs of this iſland. It is not to be wondered at, that ſuch numbers executed the immenſe deſtruction which we find in theſe buried foreſts. One of the greateſt ſubterranean treaſures of wood is that near Hatfield; and it is eaſy to prove, that theſe people, to whom this havock is thus attributed, were upon the ſpot where theſe trees now lie buried. The common road of the Romans out of the ſouth into the north, was formerly from Lindum (Lincoln) to Segelochum (Little Burrow upon Trent), and from thence to Danum (Doncaſter), where they kept a ſtanding garriſon of Criſpinian horſe. A little off on the eaſt, and north-eaſt of their road, between the two laſt named towns, lay the borders of the greateſt foreſt, which ſwarmed with wild Britons, who were continually making their ſallies out, and their retreats into it again, intercepting their proviſions, taking and deſtroying their carriages, killing their allies and paſſengers, and diſturbing their garriſons. This at length ſo exaſperated the Romans, that they were determined to deſtroy it; and to do this ſafely and effectually, they marched againſt it with a great army, and encamped on a great moor not far from Finningly: this is evident from their fortifications yet remaining.

There is a ſmall town in the neighbourhood called *Oſterfield*; and as the termination *field* ſeems to have been given only in remembrance of battles fought near the towns whoſe names ended with it, it is not improbable that a battle was fought here between all the Britons who inhabited this foreſt and the Roman troops under Oſtorius. The Romans ſlew many of the Britons, and drove the reſt back into this foreſt, which at that time overſpread all this low country. On this the conquerors, taking advantage of a ſtrong ſouth-weſt wind, ſet fire to the pitch-trees, of which this foreſt was principally compoſed; and when the greater part of the trees was thus deſtroyed, the Roman ſoldiers and captive Britons cut down the remainder, except a few large ones which they left ſtanding as remembrances of the deſtruction of the reſt. Theſe ſingle trees, however, could not ſtand long againſt the winds, and falling into the rivers which ran through the country, interrupted their currents; and the water then overſpreading the level country, made one great moraſs, and gave origin to the moſſes or moory bogs, which were afterwards formed there, by the workings of the waters, the precipitation of earthy matter from them, and the putrefaction of rotten boughs and branches of trees, and the vaſt increaſe of water moſs and other ſuch plants which, as we have already mentioned, grow in prodigious abundance in all ſuch places. Thus were theſe burnt and felled trees buried under a new formed ſpongy and watery earth, and afterwards found on the draining and digging through this earth, or moſs, again.

Hence it is not ſtrange that Roman weapons and Roman coins are found among theſe buried trees; and hence it is that among the buried trees ſome are found burnt, ſome chopped and hewn; and hence alſo it is that the bodies of the trees all lie by their proper roots, and with their tops lying north-eaſt, that is, in that direction in which a ſouth-weſt wind would have blown them.

them down: hence alſo it is, that ſome of the trees are found with their roots lying flat, theſe being not cut or burned down, but blown up by the roots afterwards when left ſingle; and it is not wonderful, that ſuch trees as theſe ſhould have continued to grow even after their fall, and ſhoot up branches from their ſides which might eaſily grow into high trees. (*Phil. Tranſ.* N° 275.)

By this ſyſtem it is alſo eaſily explained why the moor ſoil in the country is in ſome places two or three yards thicker than in others, or higher than it was formerly, ſince the growing up of peat earth or bog ground compoſed of moſs plants is well known, and the ſoil added by overflowing of waters is not a little.

As the Romans were the deſtroyers of this great and noble foreſt, ſo they were probably alſo of the ſeveral other ancient foreſts; the ruins of which furniſh us with the bog wood of Staffordſhire, Lancaſhire, Yorkſhire, and other counties. But as the Romans were not much in Wales, in the Iſle of Man, or in Ireland, it is not to be ſuppoſed that foreſts cut down by theſe people gave origin to the foſſil wood found there; but though they did not cut down theſe foreſts, others did; and the origin of the bog wood is the ſame with them and with us. Holinſhed informs, that Edward I. being unable to get at the Welſh becauſe of their hiding themſelves in boggy woods, gave orders at length that they ſhould all be deſtroyed by fire and by the axe; and doubtleſs the roots and bodies of trees found in Pembrokeſhire under ground, are the remains of the execution of this order. The foſſil wood in the bogs of the iſland of Man is doubtleſs of the ſame origin, though we have

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not any accounts extant of the time or occaſion of the foreſts there being deſtroyed; but as to the foſſil trees of the bogs of Ireland, we are expreſsly told that Henry II. when he conquered that country, ordered all the woods to be cut down that grew in the low parts of it, to ſecure his conqueſts, by cutting away the places of reſort of rebels.

The tendency of our climate to produce in cold and damp ſituations moſs plants, which gradually form around themſelves a liquor which is the enemy of all putrefaction, may be conſidered as a fortunate circumſtance, upon the whole, for the preſervation of the health of men and animals, as well as contributing to other valuable purpoſes. In conſidering the nature of moſs, "I cannot diſmiſs the ſubject (ſays Mr Headrick) without ſuggeſting my admiration at the beneficence of Providence, in having provided the moſs plants for the ſituations in which they grow: they afford an immediate ſupply of fuel, and are the ſource from which pit-coal derives its origin, though trees, and all the plants which abound in oils and carbon, alſo contribute to the ſupply of pit-coal. Were the places now occupied by moſſes diveſted of vegetables, or ſtored with vegetables of a different character, they would become noiſome fens, which, by the emiſſion of putrid gaſſes, would ſpread all around them peſtilence and death. Moſſes emit no noxious gaſſes, but rather, by growing at the ſurface, where the plants are acted upon by the ſun's rays, they perpetually throw out oxygen, and thus contribute to the ſalubrity of the atmoſphere. The only defect with which they are chargeable is, forming magazines of moiſture, which by its exhalation generates cold, and ſpreads rheumatiſm and inter-

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mitting fevers among all the animals within its reach. The perpetual evaporation of this moiſture not only tends to chill the moſs, but it deſcends in hoar-froſt and mildews upon all the lands that are lower in point of ſituation. Theſe laſt-mentioned diſadvantages are more than amply compenſated by the conſideration that moſs is not only an inexhauſtible magazine of manure for other ſoils, but may be converted into a moſt fertile ſoil itſelf. After it is ſo converted, none of the defects already ſtated are any longer applicable to it."

This gentleman analyzed chemically ſome ſpecimens of moſs. He found that a ſmall portion of Berkſhire peat of great hardneſs exhibited, when pounded in a mortar and infuſed in warm water, a liquor that had ſome ſlight marks of acidity by teſt paper. Gypſum and ſulphat of magneſia appeared to exiſt in it. A purified potaſh produced an abundant precipitation of various ſubſtances. A portion of this peat being burned, gave forth at the cloſe of the operation a ſulphureous ſmell and flame. The white aſhes, after ſome days, aſſumed a ruſty colour, from iron contained in them. Being waſhed, the liquor appeared to contain ſulphates of lime, magneſia, alumine, and iron. Black hard peat of Swinridge moor, in Ayrſhire, when burned, gave brown aſhes which were attracted by the magnet. An infuſion of them in water exhibited no mark of acid or of alkali, and the ingredients contained in it appeared to be the ſame as in the Berkſhire peat. Foggy or yellow peat yielded a ſmaller quantity of aſhes, which were white, and did not obey the magnet.

Moſs water obtained by ſqueezing light peats contained gallic acid and tanning principle in great quantities.

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tities. Quicklime appeared to be the moſt powerful agent in precipitating every ſubſtance from the moſs water, and in rendering moſs a compact and ſolid ſubſtance; a fact which, as will be afterwards noticed, has been ſucceſsfully taken advantage of in practice.

There are two ways in which a tract of territory that is covered by moſs may be reduced under the dominion of the plough, or rendered fit for the purpoſes of agriculture. The one conſiſts of altogether removing the moſſy ſubſtance, or the whole wrecks of the moſs plants that have been accumulating for ages, and endeavouring thereafter to cultivate the ſubſoil. The other mode conſiſts of converting the ſubſtance of the moſs into vegetable mould fit for bearing crops of grain.

The firſt of theſe plans has been adopted with regard to the moſs of Kincardine; and the other has been ſucceſsfully practiſed by Mr Smith of Swinridgemuir, in Ayrſhire, and in imitation of him by various other perſons in different diſtricts of the country. To each of theſe we ſhall give attention.

Moſs of Kincardine removed by human labour.

The moſs of Kincardine is a remarkable tract of ground in the ſhire of Perth, in Scotland, which deſerves particular notice, both as a topographical curioſity or ſubject of natural hiſtory, and for the information, equally uncommon and important, which it affords, reſpecting agricultural improvement, and the promotion of induſtry and population.

The moſs of Kincardine is ſituated in the pariſh of the ſame name, comprehended between the rivers Forth and Teith, and in that diſtrict of Perthſhire called *Monteith*. The moſs begins about a mile above the confluence of theſe rivers; from thence it extends in length about four miles, and from one to two in breadth; and before the commencement of the operations (an account of which is to be given), comprehended near 2000 Scots acres, of which about 1500 belong to the eſtate of Blair Drummond, the property of the late Lord Kaimes, by his marriage with Mrs Drummond of Blair Drummond.

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As moſſes are not all of the ſame nature; before entering upon the improvements made in Kincardine moſs, it will be proper to give a ſhort deſcription of that moſs, and of the ſubjacent ſoil which is the object of thoſe improvements.

The moſs lies upon a field of clay, which is a continuation of thoſe rich extenſive flats in the neighbourhood of Falkirk and Stirling, diſtinguiſhed by the name of *carſes*. This clay, which is one uniform homogeneous maſs ſinking to a great depth, is found near the ſurface, conſiſts of different colours, and is diſpoſed in layers. The uppermoſt is gray; the next is reddiſh; and the loweſt, which is the moſt fertile, is blue. Through the whole maſs not a pebble is to be found. The only extraneous bodies it contains are ſea-ſhells, which occur in all the varieties peculiar to the eaſtern coaſt of Scotland. They are diſpoſed ſometimes in beds, ſometimes ſcattered irregularly at different depths. By attending to theſe circumſtances, it cannot be doubted that the ſea has been the means of the whole accumulation, and that it was carried on in a gradual manner by the ordinary ebb and flow of the tide. Upon any other ſuppoſition, why ſhould there not have been a congeries of all the different materials that compoſe the ſurface of the ſurrounding heights? But to whatever cauſe the origin of this accumulation of clay

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may be aſcribed, certain it is that no ſoil whatever is more favourable to vegetation, or carries more abundant crops of every kind.

The ſurface of the clay, which, upon the retreat of the ſea, had been left in an almoſt level plane, is everywhere thickly covered with trees, chiefly oak and birch, many of them of a great ſize. Theſe trees ſeem to have been the firſt remarkable produce of the carſe; and it is probable they were propagated by diſſemination from the ſurrounding eminences. They are found lying in all directions beſide their roots, which ſtill continue firm in the ground in their natural poſition; and from impreſſions ſtill viſible, it is evident they have been cut with an axe or ſome ſimilar inſtrument. For the cutting of wood, the two common purpoſes are, either to apply it to its proper uſe, or that the ground it occupies may be cultivated. In the preſent caſe, however, neither of theſe ends had been propoſed, ſince the trees, by being left juſt as they were cut, were not only entirely loſt, but the ground was rendered totally unfit for cultivation. Hence it is evident, that the downfal of this wood muſt be aſcribed to ſome more extraordinary cauſe; and to none more probably than to that expedient, which, as we learn from Dion Caſſius and other hiſtorians, the Romans put ſo extenſively in practice to diſlodge from their foreſts the ancient inhabitants of the Britiſh iſlands, as already explained.

This hypotheſis acquires no ſmall degree of force from a circumſtance that occurred in May 1768, when a large round veſſel of thin braſs and curious workmanſhip, 25 inches in diameter, and 16 inches in height, was diſcovered upon the ſurface of the clay buried under

der the moſs. This veſſel, found upon the eſtate of John Ramſay, Eſq. of Ochtertyre, was by that gentleman preſented to the Antiquarian Society of Edinburgh; in whoſe muſeum it remains depoſited for preſervation. And in a liſt of the various donations preſented to that ſociety, publiſhed by them in 1782, it is there denominated a *Roman camp kettle.*

Betwen the clay and the moſs is found a ſtratum nine inches thick, partly dark brown and partly of a colour approaching to black. This is a vegetable mould, accumulated probably by the plants that covered the ground previous to the growth of the wood, and by leaves from the trees thereafter. The difference of colour muſt be owing to a difference in the vegetable ſubſtances that compoſe it. The brown mould is highly fertile; the other, eſpecially in a dry ſeaſon, is very unproductive. The crop that had occupied this mould when the trees were felled is found ſtill entire. It conſiſts chiefly of heath; but ſeveral other ſmaller plants are alſo very diſtinguiſhable.

Immediately above this ſtratum lies the moſs, to the height, upon an average, of ſeven feet. It is compoſed of different vegetables arranged in three diſtinct ſtrata. Of theſe the firſt is three feet thick. It is black and heavy, and preferable to the others for the purpoſe of fuel. It conſiſts of bent graſs *(agroſtis)*, which ſeems to have grown up luxuriantly among the trees after they were felled. The ſecond ſtratum alſo is three feet thick. It is compoſed of various kinds of moſſes, but principally of bog-moſs *(ſphagnum)*. It is of a ſallow or iron colour, and remarkably elaſtic. It is commonly called *white peat*; and for fuel is conſidered as much inferior to that above mentioned. The third ſtratum is compoſed

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poſed of heath and a little bent graſs, but chiefly of the deciduous parts of the former. It is about a foot thick, and black.

By far the greateſt part of the moſs in queſtion is, upon an average, full ſeven feet deep, and has in all probability lain undiſturbed ſince its formation: this is called the *High Moſs*. The remainder, called the *Low Moſs*, lies to a conſiderable breadth around the extremities of the high; and is, upon an average, not above three feet in depth, to which it has been reduced by the digging of peats. Theſe are formed of that ſtratum of the moſs only that lies four feet below the ſurface and downwards; the reſt is improper for the purpoſe, and is thrown aſide.

Before the introduction of the plan which is now purſued, two methods chiefly were employed to gain land from the moſs. 1ſt, The ſurrounding farmers marked off yearly a portion of the low moſs next to their arable land, about 15 feet broad. This they removed with carts and ſpread upon their fields, ſome acres of which they for that end left unſown. Here it lay till May or June; when, being thoroughly dry, it was burnt to aſhes to ſerve as a manure. By this means they added to their farms about half a rood of land yearly. But this plan proved unſucceſsful; for by the repeated application of theſe aſhes, the ſoil was rendered ſo looſe that the crops generally failed. 2dly, Many farmers were wont to *trench down* the low moſs, and to cover it *furrow deep* with clay taken out of the trench. This, though commendable as an attempt to improve, proved likewiſe an unavailing method; becauſe in a dry ſeaſon the ſuperficial covering of clay retains ſo little moiſture that the crop commonly fails.

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It has been attempted to cover the moſs with clay brought from the adjacent grounds. But what from the neceſſary impoveriſhment of the ground from which the clay was carried, and the ſoftneſs of the moſs, this was ſoon found to be impracticable.

Draining has alſo been propoſed as another mode of improvement; and it muſt be acknowledged, that, by means of draining, many moſſes have been converted both into arable and meadow grounds, which in the end became intereſting improvements. But in a moſs, ſuch as that of Kincardine, this method would be ineffectual; as for ſeveral feet deep it is of ſuch a nature, that upon being dried, and divided into parts, it would blow with the wind like chaff; and when thrown aſide in the operation of digging peats, it lies for years without producing a ſingle vegetable, except only a few plants of ſorrel.

Hence it was thought evident, that all attempts to *improve* this moſs muſt ever prove abortive; and that the object to be had in view was the acquiſition of the valuable ſoil lying underneath; to which end nothing leſs was requiſite than the total removal of the moſs.

By the methods above deſcribed from 100 to 200 acres of moſs had been removed. When the preſent plan was introduced, there ſtill remained covered with moſs from 1300 to 1400 acres of carſe clay—a treaſure for which it muſt be ever intereſting to dig.

In the year 1766 Lord Kaimes entered into poſſeſſion of the eſtate of Blair Drummond. Long before that period he was well acquainted with the moſs, and often lamented that no attempt had ever been made to turn it to advantage. Many different plans were now propoſed; at length it was reſolved to attempt, by means of water

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as the moſt powerful agent, entirely to ſweep off the whole body of moſs.

That moſs might be floated in water, was abundantly obvious; but to find water in ſufficient quantity was difficult, the only ſtream at hand being employed to turn a corn mill. Convinced of the ſuperior conſequence of dedicating this ſtream to the purpoſe of floating off the moſs, Lord Kaimes having made an agreement with the tenant who farmed the mill, and the tenants thirled conſenting to pay the rent, he immediately threw down the mill, and applied the water to the above purpoſe.

In order to determine the beſt manner of conducting the operation, workmen were now employed for a conſiderable time upon the low moſs both by the day and by the piece, to aſcertain the expence for which a given quantity of moſs could be removed. It was then agreed to operate at a certain rate per acre; and in this manner ſeveral acres were removed.

But this was to be a very expenſive proceſs. The ground gained might, indeed, be afterwards let to tenants; but every acre would require an expenditure from 12l. to 15l. before it could be ready for ſowing; ſo that the acquiſition of the whole, computing it at a medium to be 1350 acres, would ſink a capital of nearly 20,000l. ſterling.

One other method ſtill remained; namely, to attempt letting portions of the moſs, as it lay, for a term of years ſufficient to indemnify tenants for the expences incurred in removing it. For ſome time both theſe plans were adopted; but ſeveral reaſons made the latter preferable: 1. The quantity of water to be had was ſmall; and being alſo uncertain, it was very inconvenient for an undertaker; neither were there any houſes near the ſpot, which occaſioned a great loſs of time in going and coming: but when a man ſhould live upon the ſpot, then he could be ready to ſeize every opportunity. 2. The moſs was an uſeleſs waſte. To let it to tenants would increaſe the population of the eſtate, and afford to a number of induſtrious people the means of making to themſelves a comfortable livelihood.

In the mean time it was determined, till as many tenants ſhould be got as could occupy the whole water, to carry on the work by means of undertakers.

But before proceeding farther, it will be neceſſary to deſcribe the manner of applying water to the purpoſe of floating the moſs.

A ſtream of water ſufficient to turn a common corn-mill will carry off as much moſs as 20 men can throw into it, provided they be ſtationed at the diſtance of 100 yards from each other. The firſt ſtep is to make in the clay, alongſide of the moſs, a drain to convey the water: and for this operation the carſe clay below the moſs is peculiarly favourable, being perfectly free from ſtones and all other extraneous ſubſtances, and at the ſame time, when moiſt, ſlippery as ſoap; ſo that not only is it eaſily dug, but its lubricity greatly facilitates the progreſs of the water when loaded with moſs. The dimenſions proper for the drain are found to be two feet for the breadth and the ſame for the depth. If ſmaller, it could not conveniently receive the ſpadefuls of moſs; if larger, the water would eſcape, leaving the moſs behind. The drain has an inclination of one foot in 100 yards; the more regularly this inclination is obſerved throughout, the leſs will the moſs

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be liable to obſtructions in its progreſs with the water. The drain being formed, the operator marks off to a convenient extent alongſide of it a ſection of moſs, 10 feet broad; the greateſt diſtance from which he can heave his ſpadeful into the drain. This he repeatedly does till the entire maſs be removed down to the clay. He then digs a new drain at the foot of the moſs bank, turns the water into it, and proceeds as before, leaving the moſs to purſue its courſe into the river Forth, a receptacle equally convenient and capacious; upon the fortunate ſituation of which, happily forming for ſeveral miles the ſouthern boundary of the eſtate, without the interpoſition of any neighbouring proprietor, depended the very exiſtence of the whole operations.

When the moſs is entirely removed, the clay is found to be encumbered with the roots of different kinds of trees ſtanding in it as they grew, often very large: their trunks alſo are frequently found lying beſide them. All theſe the tenants remove, often with great labour. In the courſe of their operations they purpoſely leave upon the clay a ſtratum of moſs ſix inches thick. This, in ſpring, when the ſeaſon offers, they reduce to aſhes, which in a great meaſure enſures the firſt crop. The ground thus cleared is turned over, where the dryneſs admits, with a plough, and, where too ſoft, with a ſpade. A month's expoſure to the ſun, wind, and froſt, reduces the clay to a powder, fitting it for the ſeed in March and April. A crop of oats is the firſt, which ſeldom fails of being plentiful, yielding from eight to ten bolls after one.

In the year 1767 an agreement was made with one tenant for a portion of the low moſs. This, as being the

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the firſt ſtep towards the intended plan, was then viewed as a conſiderable acquiſition. The ſame terms agreed upon with this tenant have ever ſince been obſerved with all the reſt. They are as follow:

The tenant holds eight acres of moſs by a tack of 38 years; he is allowed a proper quantity of timber, and two bolls of oatmeal to ſupport him while employed in rearing a houſe; the firſt ſeven years he pays no rent; the eighth year he pays one merk Scots; the ninth year two merks; and ſo on with the addition of one merk yearly till the end of the firſt 19 years; during the laſt five years of which he alſo pays a hen yearly. Upon the commencement of the ſecond 19 years, he begins to pay a yearly rent of 12s. for each acre of land cleared from moſs, and 2s. 6d. for each acre not cleared, alſo two hens yearly: A low rent indeed for ſo fine a ſoil; but no more than a proper reward for his laborious exertions in acquiring it.

In the year 1768 another tenant was ſettled. Theſe two were tradeſmen; to whom the preference was always given, as having this great advantage to recommend them, that even when deprived of water they need never want employment. The motives that induced theſe people to become ſettlers were, 1ſt, The proſpect of an independent eſtabliſhment for a number of years, 2dly, The moſs afforded them great abundance of excellent fuel; to which was added the comfortable conſideration, that, while buſied in providing that neceſſary article, they had the double advantage of promoting, at the ſame time, the principal object of their ſettlement.

Notwithſtanding theſe inducements, ſtill ſettlers offered ſlowly: to which two circumſtances chiefly contributed;

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tributed: 1ſt, The whole farmers ſurrounding the moſs threw every poſſible obſtruction in their way. 2dly, By people of all denominations the ſcheme was viewed as a chimerical project, and became a common topic of ridicule. The plan, however, ſupported itſelf; and in the year 1769 five more tenants agreed for eight acres each; and thus 56 acres of low moſs were diſpoſed of. From the progreſs made by the firſt ſettlers, and the addition of theſe, the obloquy of becoming a moſs tenant gradually became leſs regarded; ſo that in the year 1772 two more were added; in 1773, three; and in 1774, one; in all 13: which diſpoſed of 104 acres; all the low moſs to which water could then be conveyed. As water is the main ſpring of the operation, every tenant, beſides the attention neceſſary to his ſhare of the principal ſtream, collected water by every poſſible means, making ditches round his portion of the moſs, and a reſervoir therein to retain it till wanted.

The tenants in the low moſs having now begun to raiſe good crops, in the year 1774 ſeveral perſons offered to take poſſeſſions in the high moſs, upon condition that acceſs to it ſhould be rendered practicable. The high moſs wanted many advantages that the low poſſeſſed. To the low moſs, lying contiguous to the ſurrounding arable lands, the acceſs was tolerably good; but from the arable lands the high moſs was ſeparated by 300 or 400 yards of the low, which, even to a man, affords but indifferent footing, and to horſes is altogether impracticable. The low moſs is in general only three feet deep; the high moſs is from ſix to twelve feet in depth.

It will appear at firſt ſight, that without a road of communication the high moſs muſt forever have proved unconquerable. Without delay, therefore, a road was opened to the breadth of 12 feet, for ſeveral hundred yards in length, by floating off the moſs down to the clay.

This being effected, and at the ſame time an opening given to admit water, in the year 1775 twelve tenants agreed for eight acres of high moſs each. In conſideration of the greater depth of this part of the moſs, it was agreed, that during the firſt 19 years they ſhould pay no rent; but for the ſecond 19 years the terms of agreement were the ſame as thoſe made with the tenants in the low moſs. To the above-mentioned tenants every degree of encouragement was given; as upon their ſucceſs depended, in a great meaſure, the diſpoſal of the great quantity of moſs ſtill remaining. But their ſucceſs, however problematical, was ſuch, that next year, 1776, ſix more took eight acres each; in 1777, one; in 1778, four; in 1779, three; in 1780, one; in 1781, one; in 1782, one:—In all, including thoſe upon the low moſs, 42 tenants, occupying 336 acres.

Though for ſome time the diſpoſal of the high moſs went but ſlowly on, it was not for want of tenants; but the number of operators was already ſufficient for the quantity of water; to have added more would evidently have been imprudent.

In the year 1783 Mr Drummond entered into the poſſeſſion of the eſtate of Blair Drummond, and went fully into the plan adopted by his predeceſſor for ſubduing the moſs. At this time there ſtill remained undiſpoſed of about 1000 acres of high moſs. As water was the great deſideratum, it was determined, that

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that to obtain that neceſſary article neither pains nor expence ſhould be wanting. Steps were accordingly taken to aſcertain in what manner it might be procured to moſt advantage.

Meanwhile, to prepare for new tenants, a ſecond road parallel to the former, at the diſtance of half a mile, was immediately begun and cut, with what water could be got, down to the clay, 12 feet broad and 2670 yards long, quite acroſs the moſs. This opening was previouſly neceſſary, that operators might get a drain formed in the clay to direct the water; and it was to remain as a road that was abſolutely neceſſary, and which relieved ſettlers from an expence they were unable to ſupport. Theſe preparations, the progreſs of the former tenants, and the proſpect of a farther ſupply of water, induced 10 more to take poſſeſſions in the year 1783: in the year 1784, 18 more took poſſeſſions; and in 1785 no fewer than 27:—in all 55 tenants in three years: which diſpoſed of 440 acres more of the high moſs.

As the introduction of an additional ſtream to the moſs was to be a work both of nicety and expence, it was neceſſary to proceed with caution. For this reaſon ſeveral engineers were employed to make ſurveys and plans of the different modes by which it might be procured. In one point they all agreed, that the proper ſource for furniſhing that ſupply was the river Teith, a large and copious ſtream that paſſes within a mile of the moſs; but various modes were propoſed for effecting that purpoſe.

To carry a ſtream from the river by a cut or canal into the moſs was found to be impracticable; and Mr

Whitworth, * gave in a plan of a pumping machine, which he was of opinion would anſwer the purpoſe extremely well.

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Soon after this Mr George Meikle of Alloa, a very ſkilful and ingenious millwright, gave in a model of a wheel for raiſing water entirely of a new conſtruction, of his own and his father's invention jointly. This machine is ſo exceedingly ſimple, and acts in a manner ſo eaſy, natural, and uniform, that a common obſerver is apt to undervalue the invention: But perſons ſkilled in mechanics view machinery with a very different eye; for to them ſimplicity is the firſt recommendation a machine can poſſeſs. Accordingly, upon ſeeing the model ſet to work, Mr Whitworth, with that candour and liberality of mind that generally accompany genius and knowledge, not only gave it the greateſt praiſe, but declared that, for the purpoſe required, it was ſuperior to the machine recommended by himſelf, and adviſed it to be adopted without heſitation.

The better to explain this machine, two ſketches are annexed, to the firſt of which the following letters refer. The explanation of the ſecond will be found upon the ſketch.

a, Sluice through which is admitted the water that moves the wheel.

Plate XXI.

b, *b*, Two ſluices through which is admitted the water raiſed by the wheel.

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* This gentleman was ſuperintendant of the London water works, and an engineer of great reputation in England. He was ſeveral years employed in Scotland in completing the great canal.

c, *c*, A part of one of two wooden troughs and an aperture in the wall, through which the above water is conveyed into the buckets. [The other trough is hid by two ſtone walls that ſupport the wheel.]

d, *d*, *d*, Buckets, of which 80 are arranged on each ſide of the arms of the wheel = 160.

e, *e*, *e*, A ciſtern, into which the water raiſed by the buckets is diſcharged.

f, *f*, *f*, Wooden barrel pipes, through which the water deſcends from the ciſtern under ground to avoid the high road from Stirling, and the private approach to the houſe.

Sketch ſecond contains a plan of the ciſtern, and exhibits the manner in which the water is filled into the buckets.

The diameter of the wheel to the extremities of the float-boards is 28 feet; the length of the float-boards 10 feet. The wheel makes nearly four revolutions per minute; in which time it diſcharges into the ciſtern 40 hogſheads of water. But this is not all the wheel is capable of performing; for by ſeveral accurate trials by Meſſrs Whitworth and Meikle, in the reſult of which, though made ſeparately, they perfectly agreed, it was found that the wheel was able to lift no leſs than 60 hogſheads per minute; but that the diameter of the pipes through which the water deſcends from the ciſtern would not admit a greater quantity than what they already receive.

To a perſon at all converſant in hydraulics, the reſemblance of this to the Perſian wheel muſt be obvious: and indeed it is probable, that from the Perſian wheel the firſt idea of this machine was derived. But admitting this, ſtill the ſuperiority of the preſent wheel is, in moſt reſpects, ſo conſpicuous, as to entitle it to little leſs praiſe than the firſt invention. For, 1ſt, In the Perſian wheel, the buckets being all moveable, muſt be conſtantly going out of order: In this wheel they are all immoveable, conſequently never can be out of order. 2dly, Inſtead of lifting the water from the bottom of the fall, as in the Perſian wheel, this wheel lifts it from the top of the fall, being from four or five feet higher; by which means ſome additional power is gained. 3dly, By means of the three ſluices (*a*, and *b*, *b*, fig. 1.) in whatever ſituation the river may be, the quantity of the water to be raiſed is ſo nicely adjuſted to that of the moving power, as conſtantly to preſerve the wheel in a ſteady and equable motion. In ſhort, as a regulator is to a watch, ſo are theſe ſluices to this wheel, whoſe movements would otherwiſe be ſo various, as ſometimes to carry the water clear over the ciſtern, ſometimes to drop it entirely behind, but ſeldom ſo as fully to diſcharge the whole contents of the buckets into the ciſtern.

It is however but candid to remark, that this machine labours under a ſmall defect, which did not eſcape the obſervation of Mr Whitworth; namely, that by raiſing the water about 3½ feet higher than the ciſtern where it is ultimately delivered, a ſmall degree of power is loſt. To this, indeed, he propoſed a remedy; but candidly confeſſed, that as it would render the machine ſomewhat more complex, and would alſo increaſe the friction, he thought it more adviſable to keep it in its preſent ſtate. At the ſame time he juſtly obſerved, that as the ſtream by which the wheel is moved is at all times copious and powerful, the ſmall loſs of power occaſioned by the above circumſtance was of little or no avail.

This ſtream is detached from the Teith at the place where that river approaches neareſt to the moſs. The ſurface of the latter is about 15 feet higher than that of the former; the ciſtern is therefore placed 17 feet above the ſurface of the ſtream ſo as to leave a declivity ſufficient to deliver the water upon the ſurface of the moſs.

The pipes through which the water deſcends from the ciſtern are compoſed of wooden barrels hooped with iron, 4 feet long and 18 inches in diameter within.

In theſe pipes, having been conveyed under ground for 354 yards from the ciſtern, the water at once emerges into an open aqueduct. This aqueduct, which was formed according to a plan by Mr Whitworth, is conſtructed wholly of earth or clay; and in order to keep the water on a level with the ſurface of the moſs, it is for nearly two thirds of its courſe elevated from 8 to 10 feet above the level of the adjacent grounds; the baſe being 40 feet broad, the ſummit 18 feet, and the water courſe 10 feet broad. It commences at the termination of the pipes; from whence extending above 1400 yards, it diſcharges the water into a canal formed for its reception on the ſurface of the moſs.

For raiſing the water to this height, there were two reaſons: 1ſt, That not only where it was delivered on the moſs, but even after being conveyed to the moſt diſtant corners, it might ſtill retain ſufficient power to tranſport the moſs to the river Forth. 2dly, That reſervoirs of a ſufficient height might be formed in the moſs to retain the water delivered during the night.

In conſequence of Mr Whitworth's advice, a contract

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tract was entered into with Mr Meikle in ſpring 1787; and by the end of October in that year, the wheel, pipes, and aqueduct, were all completely finiſhed; and what, in ſo complex and extenſive an undertaking, is by no means common, the different branches of the work were ſo completely executed, and ſo happily adjuſted to each other, that upon trial the effect anſwered the moſt ſanguine expectations. The total expence exceeded 1000l. ſterling.

To induce the proprietor to embark in this undertaking, the moſs tenants had of their own accord previouſly come under a formal engagement to pay the intereſt of any ſum that might be expended in procuring a ſupply of water. But he was determined they ſhould not enjoy by halves the ſweets of this long wiſhed for acquiſition. With a view, therefore, not only to reward their paſt induſtry, but to rouſe them to future exertions, he at once ſet them free from their engagement; nor has any intereſt ever been demanded.

This new ſupply was a moſt acceptable boon to the moſs tenants. In order to make an equitable diſtribution, the water raiſed through the day was allotted to one diviſion of operators; that raiſed during the night to another. To retain the latter, a canal was formed, extending almoſt three miles through the centre of the moſs. From place to place along the ſides are inſerted ſluices to admit water to the reſervoirs of the poſſeſſors; each ſluice having an aperture proportioned to the number of operators to be ſupplied from the reſervoir which it fills. For the water raiſed through the day no reſervoirs are neceſſary; as it is immediately uſed by the diviſion to which it is allotted.

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This additional ſtream, though highly beneficial, yet is not more than ſufficient to keep 40 men at conſtant work. But ſuch a quantity as would give conſtant work is not neceſſary: the operators muſt be often employed in making and repairing their drains, grubbing up roots of trees, &c.; ſo that a quantity ſufficient to give five or ſix hours work per day to the whole inhabitants is as much as would be wanted. But as the quantity procured was ſtill inſufficient for this purpoſe, a ſmall ſtream that deſcended from the higher grounds was diverted from its courſe and brought into the moſs. From want of level this ſtream could not be delivered to the greateſt advantage; namely, upon the ſurface of the moſs. Yet by making, at a conſiderable expence, a drain half a mile long, and a reſervoir for the night water, it was rendered of much importance: and during the whole winter months, as well as in ſummer, after every fall of rain, it kept 15 perſons fully employed.

In the year 1787, two more tenants agreed for eight acres each; in 1788, four; in 1789, eight; in 1790, four tenants, all agreed for the ſame number of acres.

The whole moſs was now diſpoſed of, except that part called *Flow Moſs*, which comprehends about 400 acres. Here it is twice the uſual breadth, ſo fluid that a pole may be thruſt with one hand to the bottom; and the interior part, for near a mile broad, is three feet above the level of all the reſt of the moſs. Hitherto the many and various difficulties that preſented themſelves had been overcome by perſeverance and expence. But here the extraordinary elevation of the moraſs, joined to its great fluidity, ſeemed to exclude all

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all poſſibility of admitting a ſtream of water; and it was the general opinion that the moſs operations had now arrived at their *ne plus ultra*, and that this moraſs was doomed to remain a nuiſance for ages to come.

But the proprietor had now advanced ſo far that he could not ſubmit to retreat: and he conſidered himſelf as, in ſome meaſure, pledged to the country for the completion of this undertaking. To detail the various methods practiſed to introduce a ſtream of water into that moraſs, would prove tedious. It is ſufficient to ſay, that after a thouſand unſucceſsful efforts, attended with much trouble and conſiderable expence, the point at laſt was gained, and a ſtream of water was brought in, and carried fairly acroſs the centre of the moraſs.

The greateſt obſtacle was now indeed overcôme; but ſtill another remained of no ſmall moment, namely, the diſcouragement given to ſettlers from the total impoſſibility of erecting habitations upon the ſurface of this moraſs. To find a remedy for this evil was difficult. Happily a reſource at laſt occurred. This was to bargain with a certain number of the old tenants, whoſe habitations were neareſt, to take leaſes of portions of the moraſs. But as ſome additional aid was here neceſſary, it was agreed that 12l. ſterling ſhould be gradually advanced to each tenant till he ſhould accompliſh the clearing of an acre, for which he or his ſucceſſor is bound to pay 12s. of yearly rent, equal to five per cent. upon the ſum advanced. When this point ſhall be gained, they are bound to diſpoſe, as moſt agreeable to themſelves, either of their old or of their

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new poſſeſſion; for which, when once an acre is cleared, purchaſers will not be wanting.

In conſequence of the above arrangement, during the year 1791 no fewer than 35 of the old tenants agreed, upon the foreſaid conditions, for eight acres each of the flow moſs. Thus 1200 acres are now diſpoſed of to 115 tenants. But when theſe 35 tenants ſhall each have cleared their acre, then, according to agreement, 35 additional tenants will ſpeedily be acquired; and the moſs will then contain in all 150 families.

To the leaſes at firſt granted to the tenants in the high moſs, it was afterwards determined to add a further period of 19 years (making in all 57 years), during which they are to pay one guinea per acre; a rent not greater than the land is worth even at preſent, but greatly below its probable value at that diſtant period. This, it is hoped, will prove to the tenants a ſufficient incitement to continue their operations till their poſſeſſions are completely cleared from moſs.

Having now gone through, in detail, the whole progreſs of the colony for many years after its firſt ſettlement in the year 1767, it ſtill remains to take a general view of the effects produced by that eſtabliſhment.

For ſeveral years, at firſt, the water was uſed chiefly to carry off moſs, in the forming of new roads, and preparing reſervoirs; which conſiderably retarded the principal object, of gaining land. Nevertheleſs there have been cleared full 300 acres of excellent land, producing wheat, barley, oats, and clover, yielding from ſix to twelve bolls after one.

From the nature of the undertaking, there is good reaſon to ſuppoſe that the operations will yearly advance

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vance with greater rapidity; eſpecially as the greater number of the ſettlers have only of late begun to operate. Many, beſides maintaining their families otherwiſe by occaſional employments, have in the high moſs, cleared in a year one rood of land; ſome have cleared two, ſome three roods, and in the low moſs an acre.

It was a remark often made, even by perſons of ſome obſervation, that by collecting together ſuch a number of people, Kincardine would be overſtocked; and the conſequence would be their becoming a burden on the pariſh: for as the bulk of them were labourers not bred to any trade, and poſſeſſed of little ſtock, it was foreſeen, that, for ſome time, they could not afford to confine themſelves ſolely to the moſs, from which the return muſt be ſlow; but behoved, for immediate ſubſiſtence, to work for daily hire. Happily theſe predictions have proved entirely groundleſs; for ſuch is the growing demand for hands in this country, that not only do the whole of theſe people find employment whenever they chooſe to look for it, but their wages have been yearly increaſing from the time of their firſt eſtabliſhment. In ſhort, they have proved to the corner where they are ſet down a moſt uſeful nurſery of labourers; and thoſe very farmers who, at firſt, ſo ſtrongly oppoſed their ſettlement, now fly to them as a ſure reſource for every purpoſe of agriculture. Still they conſider the moſs operations as their principal buſineſs; none pay them ſo well; and when they do leave it to earn a little money, they return with cheerfulneſs to their proper employment. Many of them already raiſe large quantities of grain, and have no occaſion to go off to other work; which will ſoon be

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the caſe with the whole. Their original ſtock, indeed, did not often exceed 25l. and ſome had not even 10l.; but what was wanting in ſtock was compenſated by induſtry.

Of the whole inhabitants full nine-tenths are Highlanders, from the neighbouring pariſhes of Callander, Balquhidder, &c.; a ſober, frugal, and induſtrious people, who, inured to hardſhips in their own country, are peculiarly qualified to encounter ſo arduous an undertaking. From this circumſtance, too, ariſes a very happy conſequence; that wearing a different garb and ſpeaking a different language from the people amongſt whom they are ſettled, they conſider themſelves in a manner as one family tranſported to a foreign land: and hence upon all occaſions of difficulty, they fly with alacrity to each others relief. Neither ought it to be forgotten, that, from their firſt ſettlement to the preſent day, not a ſingle inſtance has occurred amongſt them of theft, bad neighbourhood, or of any other miſdemeanour, that required the interpoſition of the civil magiſtrate. Nor, however poor in circumſtances, has any one of them ever ſtooped to ſolicit aſſiſtance from the funds of the pariſh appropriated to that purpoſe.

Though few of the tenants entered with a large ſtock, one only has been obliged to leave the moſs from incapacity to proceed. Many indeed have ſpent their ſmall ſtocks, and even run a little in debt: but in this caſe they have been permitted to ſell their tacks upon the following conditions: 1ſt, That the purchaſer ſhall be a good man; 2dly, That the ſeller ſhall take another poſſeſſion. By this manoeuvre a new inhabitant is gained; while the old one, relieved from debt, and aided by paſt experience, recommences his operations with double ſpirit upon a new poſſeſſion. The monied man again has at once a houſe and a piece of ground, the want of which chiefly ſtartled new beginners.

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Some have even made a kind of trade of ſelling; inſomuch, that from the year 1774 to the year 1792, no fewer than fifty ſales took place, producing in all the ſum of 849l. ſterling. This proved from time to time a moſt ſeaſonable recruit to the colony, and gave new vigour and ſpirits to the whole.

The number of the ſettlers is productive of an excellent effect; that although ſome are generally abſent, enough ſtill remain to occupy the water conſtantly. In a favourable day, there may be ſeen hundreds, men, women, and children, labouring with the utmoſt aſſiduity. The women declare they can make more by working at the moſs than at their wheel; and ſuch is the general attachment to that employment, that they have frequently been diſcovered working by moonlight.

Another happy conſequence ariſing from their numbers is the great quantity of moſs they conſume for fuel. There are in all 115 families. Each family requires at an average 10 dargues * of peats yearly. Each dargue uncovers a ſpace equal to 10 ſquare yards of clay: ſo that, by caſting peats, the moſs tenants gain yearly about 6 roods of land.

The advantage, too, of providing their fuel with ſo little trouble, is very great. They require yearly 1150

dargues

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* A dargue (or darg) of peats, is the quantity that one man can caſt and two can wheel in a day to the field where they are ſpread out to dry.

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dargues of peats; which, as each dargue when dried and ſtacked is valued at five ſhillings, are worth 287l. 10s. ſterling; a ſum which otherwiſe muſt have been expended on the prime coſt and carriage of coals.—Many of them caſt peats for ſale; and 100l. worth are yearly diſpoſed of in the town of Stirling, the village of Down, &c.

Though moſs work be laborious, it is at the ſame time amuſing. The operator moves the moſs five feet only at a medium; and the water, like carts in other caſes, carrying it off as faſt as it is thrown in, excites him to activity. Still he muſt ſubmit to be wet from morning to night. But habit reconciles him to this inconvenience; while his houſe and arable land fill his eye and cheer his mind. Nor is it found that the health of the inhabitants is in the ſmalleſt degree injured either by the nature of the work or the vicinity of the moſs.

The quantity of moſs that one man can move in a day is ſurpriſing; when he meets with no interruption, ſeldom leſs than 48 cubic yards, each weighing 90 ſtones. The weight, then, of moſs moved per day is no leſs than 4320 ſtones. A cubic yard is moved into the water, and of courſe carried into the river Forth for one farthing. It follows, that the expence of moving 48 cubic yards is one ſhilling. But the ſame quantity moved to the ſame diſtance by carts would coſt 24 ſhillings. Hence the advantage derived from the poſſibility of floating moſs in water, and the great importance of having water for that purpoſe.

The moſs, when contraſted with the rich lands ſurrounding, appeared, eſpecially before the improvements, a very dreary ſpot; one wide unvaried wild, totally

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totally unproductive, unfit even to furniſh ſuſtenance to any animal, except here and there a few wretched ſtraggling ſheep. Beſides, it entirely cut off all connexion betwixt the farms on either ſide; among which no intercourſe was practicable but by a circuit of ſeveral miles.

The ſcene was ſoon greatly changed. The following are the numbers of the inhabitants who ſome years ago reſided in the moſs; alſo of their cows and horſes, and of the acres gained by them from the moſs, together with their produce.

Men - -	115
Women - -	113
Boys - -	199
Girls - -	193
Total	620

Number of cows, at leaſt, -	115
Ditto of horſes and carts - -	34
Ditto of acres cleared from moſs -	300

The produce in bolls cannot be exactly aſcertained: but, conſidering the goodneſs of the ſoil, may be fairly ſtated at eight bolls per acre. *Inde* 2400 bolls.

As oats are the ſtaple commodity, the calculation ſhall be confined to that grain. According to the fiars of Stirlingſhire, crop 1790, carſe oats are valued at 14s. per boll. *Inde* 2400 bolls at 14s. is 1680l. Of late this price has at times been doubled.

A tract of ground ſo conſiderable, formerly a nuiſance to the country, thus converted into a fertile field filled with inhabitants, comfortable and happy, cannot ſurely be ſurveyed with an eye of indifference by any paration Land.

perſon whoſe mind is at all ſuſceptible of feeling or of public ſpirit.

An excellent gravelled road, 20 feet wide and a mile and a half long, is now carried quite acroſs the moſs. By this means, in the firſt place, a ſhort and eaſy intercourſe is eſtabliſhed between two conſiderable parts of the eſtate, formerly as little connected as if ſeparated by a lake or an arm of the ſea. Secondly, The inhabitants of the moſs, to whom, hitherto, all paſſage with carts or horſes was impracticable for at leaſt one half of the year, have now obtained the eſſential advantage of being able, with eaſe, to tranſport all the different commodities at every ſeaſon of the year. This road was entirely formed by the hands of the moſs tenants, and gravelled by their own carts and horſes: a work which, it will not be doubted, they performed with much alacrity; when it is conſidered that, to the proſpect of procuring a laſting and material benefit to themſelves, there was joined the additional inducement of receiving an immediate ſupply of money, the whole being done at the proprietor's expence.

The poſſeſſions are laid off in the manner beſt fitted for the operations; and are divided by lanes running in ſtraight lines parallel to each other. Parallel to theſe again the drains are carried; and this ſtraight direction greatly facilitates the progreſs of the water with its load of moſs. Upon the bank of moſs fronting the lanes, the operation of floating is begun; and twenty or thirty people have been ſometimes ſeen heaving moſs into the ſame drain. That the water might be the more conveniently applied, the lanes include between them the breadth of two poſſeſſions only. The new houſes are erected upon each

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each ſide of theſe lanes at the diſtance of 100 yards from each other.

Before the formation of lanes and roads, and while yet no ground was cleared, the firſt ſettlers were obliged to erect their houſes upon the ſurface of the moſs. Its ſoftneſs denied all acceſs to ſtones; which, at any rate, are at ſuch a diſtance as would render them too expenſive. Settlers, therefore, were obliged to conſtruct their houſes of other materials. Upon the low moſs there is found for this purpoſe great plenty of ſod or turf, which accordingly the tenants uſe for the walls of their houſes. For the rudeneſs of the fabric nature in ſome meaſure compenſates, by overſpreading the outſide with a luxuriant coating of heath and other mooriſh plants, which have a very picturesque appearance.

But upon the high moſs there is no ſod to be found. There the tenant muſt go differently to work. Having choſen a proper ſituation for his houſe, he firſt digs four trenches down to the clay, ſo as to ſeparate from the reſt of the moſs a ſolid maſs, containing an oblong rectangular area, ſufficiently large for his intended houſe. This being done, he then ſcoops out the middle of the maſs, leaving on all ſides the thickneſs of three feet for walls; over which he throws a roof, ſuch as that by which other cottages are commonly covered.

Upon the ſofteſt parts of the moſs, even theſe walls cannot be obtained. In ſuch places the houſes are built with peat dug out of the moſs, and cloſely compreſſed together while in a humid ſtate *. It is neceſſary

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* This does not apply to the moraſs, upon the ſurface of which, it has already been obſerved, it is impoſſible to erect houſes in any ſhape.

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ſary even to lay upon the ſurface a platform of boards to prevent the walls from ſinking; which they have frequently done when that precaution was neglected. After all, to ſtamp with the foot will ſhake the whole fabric as well as the moſs for fifty yards around. This, at firſt, ſtartled the people a good deal; but cuſtom ſoon rendered it familiar.

The coloniſts have now made conſiderable advancement in rearing better habitations for their comfort and convenience. Their huts of turf are but temporary lodgings. As ſoon as they have cleared a little ground, they build houſes of brick: when the proprietor a ſecond time furniſhes them with timber gratis. It has alſo been found neceſſary to relieve them entirely from the payment of the burdenſome tax upon bricks; a tax which ſurely was never intended to fall on ſuch poor induſtrious adventurers; and which, without this aſſiſtance, would have proved a moſt effectual bar to the employment of theſe materials.

There are now erected in the moſs 69 brick houſes, ſubſtantially built with lime. The total expence amounted to 1033l. ſterling. And it is a very comfortable circumſtance, that the money expended upon theſe houſes is moſtly kept in circulation among the inhabitants themſelves; for as a number of them have learned not only to manufacture but alſo to build bricks, and as others who have horſes and carts furniſh the carriage of lime and coals, they thus interchange ſervices with each other.

With a view to excite the exertion of the coloniſts, the following premiums were alſo offered: 1. To the perſon who ſhall in the ſpace of one year remove the greateſt quantity of moſs down to the clay, a plough of

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of the beſt conſtruction. 2. To the perſon who ſhall remove the next greateſt quantity, a pair of harrows of the beſt kind. 3. For the next greateſt quantity, a ſpade of the beſt kind, and 10lb. of red clover ſeed. But as theſe premiums, if conteſted for by the whole inhabitants, could reach but a very few of the number, they were therefore divided into ſix diſtricts according to their ſituation; and the above premiums were offered to each diſtrict.

The eſtabliſhment of this colony was no doubt attended with a very conſiderable ſhare of expence and difficulty; for the undertaking was altogether new, and there were many prejudices againſt it, which it was neceſſary to overcome. At the ſame time it was noble and intereſting: it was to make a valuable addition to private property: it was to increaſe the population of the country, and to give bread to a number of people; many of whom having been turned out of their farms and cottaries in the Highlands, might otherwiſe, by emigration, have been loſt to their country; and that too at a time when, owing to the great enlargement of farms, depopulation prevails but too much even in the low countries. And it was to add to the arable lands of the kingdom, making many thouſand bolls of grain to grow where none ever grew before.

Theſe conſiderations have hitherto preponderated with the proprietors againſt the various obſtacles that preſent themſelves to the execution of ſo extenſive an undertaking. Should their example tend in any degree to ſtimulate others, who both in Scotland and in England poſſeſs much ground equally uſeleſs to the country, to commence ſimilar improvements, it would

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be a moſt grateful conſideration ſuperadded to the pleaſure already ariſing from the progreſs of the infant colony.

On account of the importance of the ſubject, we have here inſerted the above detail, which was written ſome years ago, of the improvements carried on in the moſs of Kincardine, commonly called *Moſs Flanders*. But after all, it will probably hereafter be thought, that the great efforts of ingenuity, and of perſevering induſtry, which were requiſite in the above operation, might all have been avoided, and the work much eaſier performed, had the art been found out of converting moſs into fruitful ſoil, according to the plan practiſed, and undoubtedly brought to great perfection in Ayrſhire, by the gentleman already mentioned, John Smith, Eſq. of Swinridge muir, near Beith. On a part of a moſs in this gentleman's property, a quantity of lime had been ſpread in conſequence of the miring of ſome carts in wet weather; to relieve which, their load was laid over the ground in their neighbourhood, though this was accounted at that period an abſurd operation, as it was believed that lime would have the effect of conſuming and rendering moſſy ground uſeleſs for ever. The proprietor, Mr Smith, was then in the army, towards the cloſe of the American war. On returning home the ſucceeding ſummer, and being informed of the accident, he was ſurpriſed to find that as good a crop grew upon the patch of moſs on which the lime had been ſcattered, as upon another ſpot that had been pared and burned, in conſequence of inſtructions that he had tranſmitted home for that purpoſe, from having peruſed ſome treatiſes in which burning of moſs was recommended. He alſo remarked, that upon the places which

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which had neither been burned nor limed, nothing grew, and that the crop upon the burned ſoil was inferior to that where the lime had been laid, being almoſt choked with ſorrel. Mr Smith purſued the hint thus obtained: He reclaimed by means of lime every portion of moſs in his own poſſeſſion, and having ſatiſfied his tenants of the utility of the practice, he allowed them to dig limeſtone gratis, and gave them the refuſe of his coal at prime coſt to burn it. Thus, in a ſhort time, every part of the moſs upon his eſtate was reduced under cultivation, and rendered highly valuable.

When Mr Smith began his operations, he met the fate of innovators in agriculture, that is, he was ridiculed by all his neighbours. His ſucceſs, however, at length made ſome converts, and though the new ſyſtem at firſt advanced ſlowly, it was at laſt univerſally approved of, and extenſively imitated. The reſult has been, that what was once the worſt land in the country, is now become the moſt productive and fertile.

The following is a conciſe ſtatement of Mr Smith's practice, and conſequently of the Ayrſhire practice, of actually converting moſs into vegetable mould, capable of bearing rich crops of corn, hay, potatoes, &c. which we ſhall give in the words of Mr Headrick *.

" 1. When they enter upon the improvement of a moſs in its natural ſtate, the firſt thing to be done is, to mark and cut main or maſter drains, eight feet in width, by four and a half in depth, and declining to two and a half at bottom; theſe coſt 1s. per fall of ſix Scots ells. In ſome inſtances, it will be found neceſſary

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* *Communications to the Board of Agriculture*, vol. ii.

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" When the moſs lies in a hollow, with only one outlet, it is neceſſary to lead up a drain, ſo as to let the water paſs this outlet, and then conduct it along the loweſt or wetteſt part of the moſs: this middle drain is afterwards ſloped, and the ſtuff thrown back into the hollows that may occur; upon it the ridges are made to terminate on each ſide, while a ring drain, ſerving the purpoſe of a fence, is thrown round the moſs at the line where the riſing ground commences. This can generally be ſo managed as to divide the moſs into a ſquare field, leaving ſtraight lines for the ſides of the contiguous fields. The ring drain intercepts the ſurface water from the higher grounds, and conducts it into the lower part of the outlet, while the ſloped drain in the centre receives and diſcharges all the water that falls upon the moſs.

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After the moſs collapſes in conſequence of liming and culture, it is often neceſſary to clean out theſe drains a ſecond time, and to dig them to a greater depth: their ſides become at laſt like a wall of peat, which few animals will venture to paſs.

" 2. The drains being thus completed, they mark out the ridges, either with a long ſtring or with three poles ſet in a line. Mr Smith has tried ſeveral breadths of ridges, but now gives a decided preference to thoſe that are ſeven yards in breadth. The ridges are formed with the ſpade in the following manner: In the centre of each intended ridge, a ſpace of about two feet is allowed to remain untouched; on each ſide of that ſpace a furrow is opened, which is turned over ſo as completely to cover that ſpace, like what is called *veering* or *feering* of a gathered ridge; the work, thus begun, is continued by cutting furrows with the ſpade, and turning them over from end to end of the ridge on each ſide, until they arrive at the diviſion furrows. The breadth of the ſlices thus cut, may be about 12 inches, and each piece is made as long as it may ſuit to turn over: the ridge when finiſhed, has the appearance of having been done with a plough. The diviſion furrow is two feet in breadth, which if neceſſary to draw off ſuperfluous water, is partly cut and thrown upon the ſides, or into hollows in the ridges on each ſide. The depth of the diviſion furrows is regulated by circumſtances ſo as not to lay the ridges at firſt too dry, but at the ſame time, to bleed, as it were, the moſs, and conduct the ſuperfluous water into the maſter drains.

" 3. The next operation is to top-dreſs the ridges with

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with lime. The ſooner this is done after the ridges are formed, the better. When the moſs appears dry, experienced farmers throw on the lime, but do not clean out the diviſion furrows until the enſuing winter. When it is ſoaked in water, they clean the diviſion furrows as ſoon as the lime is ready, and after the water has run off apply the lime immediately. It is of great importance to have the lime applied while the moſs is ſtill moiſt, and the lime in as cauſtic a ſtate as poſſible. For this purpoſe, they have the lime conveyed from the kiln in parcels, ſlaked and laid on as faſt as the ridges are formed. Being dropped from carts, and ſlaked at the neareſt acceſſible ſtation, it is carried to the moſs by two men on light handbarrows, having a hopper and bottom of thin boards, and there ſpread with ſhovels as equally as poſſible. During the firſt and ſecond years, the crop is generally carried off in the ſame way. In ſome places where a moſs is covered with coarſe herbage, and acceſſible by carts in dry weather, I ſaw them give a good doſe of lime to the moſs before it was turned up with the ſpade, and another after the ridges were formed. It is ſurpriſing how quickly they execute theſe operations with the handbarrows. In other places where coarſe boards can be procured, they lay a line of them along the crown of a ridge, and convey the lime upon them in wheelbarrows.

" The proportion of lime allowed to the acre is various, being from three to eight chalders. Improvers are much leſs ſparing of this ingredient now than formerly, and much greater proportions have been applied with good effect. Suppoſe 120 bolls, or 480 Wincheſter buſhels, of ſlaked or powdered lime allowed to every Scots acre, this would coſt at the ſale kilns 40s.; and thus the reader may be enabled to calculate the expence of lime in this diſtrict at every given proportion: But moſt of the farmers here burn lime for themſelves in vaſt kilns of ſod, and think they have it much cheaper than it could be got from a ſale kiln. In many places, limeſtone abounds ſo much, that houſes, fences, and roads are conſtructed with it; and when a farmer burns the limeſtone within his premiſes, he at leaſt ſaves the expence of carriage.

"In ſome caſes, after the limeſtone is laid on, they go over the ground with hoes, or with ſpades, hacking and maggling the clods, and mixing the lime more completely with the ſuperficial ſoil; but where there is much to do, and hands are ſcarce, they never think of theſe operations.

"4. The field thus prepared is ready to receive the ſeed, which is ſown at the proper ſeaſon whether it be *wet* or *dry*, and harrowed in with a ſmall harrow drawn by two men. Four men will with eaſe harrow at leaſt five or ſix roods per day, two and two dragging the harrow by turns, and two breaking and dividing the mould with ſpades. When the lime has been applied early the preceding ſummer, a good crop of oats may generally be expected; but if it has been recently applied, the firſt crop of oats frequently miſgives, as the lime has not time to combine with the moſs, and form it into a ſoil.

"The early Dutch or Poliſh oats are always preferred by moſs improvers, as the common Scots or late oats are too apt to run into ſtraw, and lodge before the grain arrives at maturity. The ſame proportion of ſeed is allowed per acre that is uſual in other places. The

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The great deſideratum is, to procure plants which will throw up a ſufficient quantity of herbage, ſo as to ſhield the ſurface from the winds and ſun's rays, and thus to keep it moiſt during the firſt ſummer after a moſs is reclaimed.

This deſideratum is effectually ſupplied by the potato, which thrives well on moſs at all times, whether recently opened up and limed, or at any future period of its cultivation; only it requires a proportion of ſtable dung. It is now become the general practice in Ayrſhire, to plant potatoes on thoſe moſſes which have been but recently turned up and limed; and where dung can be procured, it is generally the firſt crop on all their moſſes.

"The method of planting potatoes, whether they be the firſt crop or ſucceed the firſt crop of oats, is by lazy beds. If they be the firſt crop, the moſs having been delved into ridges, and limed as before directed, ſpaces of from five to ſix feet in breadth are marked out acroſs the ridges, having intervals of about two feet, from which the moſs is taken to cover the ſets. Theſe ſpaces or beds are covered over with a thin *ſtratum* of dung, laid upon the ſurface of the lime at the rate of about ſixteen tons to the Scots acre. The cuttings of the potatoes are laid or placed upon the ſaid beds, about ten or twelve inches aſunder; and the whole are covered over with moſs, taken from the intervals which are thus converted into ditches, to be followed by another covering about the time the potato plants begin to make their appearance, the covering in the whole amounting to about four or five inches; at the ſame time the diviſion furrows are cleaned out to cover the ſets that are contiguous to them.

The whole field is thus divided into ſpaces or lazy beds, like a chequered board. During ſummer, they cut the moſs with hoes, and draw it up a little towards the ſtems of the plants. Few weeds appear, except what are conveyed by the dung. This is the practice univerſally followed when potatoes are planted on moſs for the firſt time; but after the moſs is finely pulverized and reduced, they either plant them in rows acroſs the ridges, or plant and dreſs them with the plough in the uſual manner.

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"Potatoes planted as the firſt crop never miſgive, and they are the beſt and moſt certain method at once to reclaim a moſs, not owing ſo much perhaps to the dung aiding the putrid fermentation which the lime has already excited, as to their roots puſhing and dividing the moſs, while their leaves ſhelter it from the ſun, cauſe a ſtagnation of air, and thus keep it in that degree of moiſture which is moſt favourable to the action of lime upon moſs. The practice of making potatoes the firſt crop is now univerſally followed, in ſo far as the farmers can command dung. The produce is from 40 to 60 bolls per acre, the potato meaſure being eight Wincheſter buſhels a little heaped to the boll. Moſſes that are fully reclaimed yield from 60 to 70 bolls of potatoes at an average, and in ſome places where manures are abundant, they have been known to yield from 80 to 100 bolls per acre, of the above meaſure.

"Mr Smith is about to try yams upon his moſſes, from the opinion that prevails among ſome of the Mid-Lothian farmers, where this plant is much cultivated, that they require little or no dung, and that the ſuperior breadth of their leaves will prove more favourable than thoſe of potatoes, for ſheltering the ground.

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"When the potato crop is removed, the ridges are again put into their original form; in doing which, care is taken to preſerve the mould that is acquired uppermoſt; this is done by moving the ſubfurrow on each ſide with a ſtrong ſpade, half way into the intermediate ditch from which the lazy beds were covered, and ſcattering the mould equally over the whole ſurface. This operation coſts 18s. per acre. It is not eaſy to calculate the expence of planting the potatoes, forming the lazy beds, &c. as this is ſeldom executed by contract; but the lazy beds being thus reduced, the land is ready for a crop of corn.

"Though a crop of oats frequently miſgives upon moſs that has been but recently limed, yet in other caſes, when the lime has lain ſeveral months upon the land, it proves a good crop, and is ſufficient to cover all the expence with a little profit. The crops of ſucceeding years are ſufficient to afford from their ſtraw putreſcent manure for ſuch land in order that it may be cleaned with potatoes, and prepared for graſs ſeeds.

"But after potatoes of the firſt year, with the ſlight operation of reducing the lazy beds, from 10 to 12 bolls of oats are at an average produced per acre. The oats are excellent, and yield from 18 to 20 pecks of meal per boll; they would ſell upon the ground for 10l. or 12l. per acre. The ground continues to yield oats of the ſame quality for ſeveral years, without any apparent diminution of fertility, and without receiving any additional manure: the only apparent bar to the continuance of this crop is, the ſoil becoming graſſy. When the graſs begins to contend with the crop for pre-eminence, the land is thrown into paſture, and would let ever after

ter in that ſtate at from 20s. to 25s. per acre. Daiſies, white clover, &c. &c. now ſpring up in moſſes, where their exiſtence was never before ſuſpected; at the ſame time, thiſtles and other weeds for ſome time infeſt the paſture.

"The better practice is, to take another crop of potatoes with a little dung and lime, and give it a trench-delving, to bury the weeds and bring up new ſoil; after the potatoes to ſow barley and graſs ſeeds.

"Rye-graſs is univerſally ſown here, and it attains amazing perfection upon moſs properly prepared; along with this, white and yellow clover are ſometimes ſown, and thrive remarkably well. Red clover has been tried, but did not ſucceed, and is hence diſcredited for moſs-lands: perhaps it may have been unjuſtly cenſured, becauſe it is certain that the ſeaſons in which it was tried, proved very unfavourable to red clover in all parts of the country, moſt of it having died during winter.

"5. We have already deſcribed the levelling of the lazy beds. All future delvings of the moſs are performed from one end of the ridge to the other; by this method the ſlices that had been cut and turned over in the firſt operation of forming the ridge, are again cut acroſs, and conſtantly reduced into ſmaller pieces, till they moulder into earth.

"The expence of delving a moſs for the firſt time, where the ſurface is tolerably ſmooth, is 2½d. per fall, or 1l. 13s. 4d. per Scots acre; but where inequalities occur, which muſt be thrown down by the ſpade into hollows, it coſts about 2l. per acre. If there be eminences, which muſt be removed into hollows by wheelbarrows running upon boards, the firſt expence is great-

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er according to circumſtances. The ſecond delving, where potatoes have not intervened, coſts from 1l. to 1l. 6s. per Scots acre, the diviſion furrows being at the ſame time cleaned out. The third delving and cleaning of the diviſion furrows coſts 1l. per acre; but the moſs is now ſo friable, that it may be wrought with the the greateſt eaſe and rapidity. At the above rates, an ordinary workman will earn 1s. 6d. per day, and an able and experienced one, from that to 2s. 6d. per day. They uſe a ſtrong ſpade, edged with ſteel, and have always a gritſtone near them for ſharpening the ſpade. In the evenings they repair its edge upon a grindſtone; and when the ſteel is worn away, they lay it again with new ſteel. Sometimes the moſs is ſo ſoft that they walk upon boards while they are turning it over.

"Mr Smith has found, by long experience, that it is improper to make the ridges too high or too narrow: when they are too high, they throw the water off from their ſides without admitting it to penetrate their ſubſtance; the top of courſe gets too dry: when too narrow, there is a loſs of ſurface from too many diviſion furrows. The breadth already mentioned is found to be the beſt: and when the improvement is completed, the ridges appear like ſegments of wide circles, with a clean well-defined diviſion furrow between each of them. The moiſture is thus cauſed ſlowly to filtrate through the moſs rendered friable by lime until it reaches the diviſion furrows, and is diſcharged. As the moſs ſubſides for ſome time, and cloſes in towards the furrows, it is generally neceſſary to clean theſe out before winter, and at the time the crop is ſown, until the moſs acquire ſolidity.

"Some moſſes may be ploughed the ſecond year to within two bouts or four ſlices of the diviſion furrows, and every operation performed by the force of horſes, except turning over with the ſpade the narrow ſtripes next to the diviſion furrows. In other moſſes it requires three years before this can be done; and it ſeldom happens but every moſs may be wrought by the plough after it has been wrought four years by the ſpade. When moſs is wrought by the ſpade, it ſeems of no conſequence whether it be wrought wet or dry; but when it is wrought by the plough, opportunities muſt be watched, as horſes cannot walk upon it for ſome years during wet weather.

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" 6. With reſpect to the quality of the potatoes thus produced upon moſſes, I do not ſcruple to pronounce it moſt excellent. Potatoes have been tried with dung alone; but they are always watery, and frequently hollow or rotten in the heart: thoſe raiſed upon moſſes that have been well limed, are frequently ſo dry and farinaceous, that it is difficult to boil them without reducing them to powder; and they are often obliged to lift them with ſpoons: they come clean out of the ground; keep remarkably well in heaps covered with moſs in the field; and are remarkably well flavoured.

" No ſuch diſeaſe as the curl was ever known among moſs potatoes; and, indeed, if Dr Coventry's opinion be true, that the curl is cauſed by overloading the ſets with too much earth, or from the earth becoming too hard around them; no ſuch thing can take place in moſs. But to whatever cauſe the curl may be owing, it is certainly propagated by diſeaſed ſeed; it would, therefore, appear advantageous to transfer the potatoes raiſed upon moſs as ſeed for ſolid land. They have a

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remarkably good ſpecies of potato in this diſtrict, which was brought from Virginia to Largs about eight years ago; and whether it be owing to the beneficial nature of a moſſy ſoil, or to its own intrinſic merits, this potato has long been ſo much diſtinguiſhed by the good quality and large quantity of its produce, that it has ſuperſeded the uſe of every other ſpecies. There ſeems to be no occaſion for moſs improvers to change their ſeed. Some perſons in this diſtrict, who have but ſmall patches of moſs, have kept them conſtantly in potatoes more than ten years, without changing the ſeed, and without any ſenſible diminution either in the quantity or quality of the crop."

4. *Of bringing Land into Culture from a State of Nature.*

Before attempting to bring under cultivation land that has hitherto remained in a totally rude ſtate, the firſt conſideration with a prudent man ought undoubtedly to be, how far he is able to ſupport the expence of the undertaking. If conducted with ſkill, it will in almoſt all practicable caſes pay well; but a ſtout capital is neceſſary, becauſe, if only half meaſures are followed, the whole expence is apt to be loſt. This remark, however, is only made with regard to enterpriſes made upon a great ſcale; for ſmall portions, eſpecially of a dry mooriſh ſoil, may undoubtedly be improved by neighbouring farmers at a moderate coſt.

The firſt ſtep to be taken towards the improvement of waſte lands is, to drain them from all ſuch wetneſs as might have a tendency to injure their fertility when brought into a ſtate of cultivation. There are few inſtances of waſte lands, eſpecially in the neighbourhood of hills, in which ſome degree of draining is not requiſite.

ſite. Till proper drains are formed and completed, it is impoſſible for an improver to form a correct plan for directing his future procedure, becauſe it frequently happens that the wetneſs of a ſoil, eſpecially at the foot of mountains, is occaſioned by very powerful ſprings, which, if let out or tapped by a ſkilful mode of draining, and their waters united into a common current, might form a ſtream of conſiderable importance. In all ſuch caſes, ſuch a ſtream ought to be uſed for the purpoſe of flooding or watering the inferior lands. The plough ought to be abſtained from, and no farther or more expenſive improvement adopted upon theſe lower grounds. The important art of flooding lands, or of irrigation, will be afterwards explained. In the mean time, it may be here remarked, that there is ſcarcely a piece of waſte territory in this country which does not contain ſpontaneous proofs of the value of irrigation. We everywhere ſee firm ſpots by the ſides of torrents, which from temporary flooding acquire a beautiful verdure that proves a remarkable contraſt to the dreарineſs of the ſurrounding waſte; and wherever little rills are found not conſiderable enough to cut a regular bed for their waters, but which ſpread at times over the mountains ſides, we obſerve their courſe univerſally marked by a track of green, in conſequence of the deſtruction of the heath in theſe ſpots by the temporary overflowing of the water. Wherever by any means a ſtream can in like manner be made to overflow at times, or to ſpread itſelf abroad upon the whole ſurface of the ground, the heath and coarſer plants will paſs away, and give place to the finer herbage by which cattle or ſheep are ſupported.

When the draining is finiſhed, the lands which canaration Land.

not become objects of irrigation may be fertilized by lime, or by means of the practice of paring and burning.

To improve a moor by lime, let it be opened in winter. A ſtrong doſe of cauſtic lime ought as ſoon as poſſible to be laid upon the ſurface of the land in a ſtate of fine powder, that it may attach itſelf to every part. The lime will conſume the roots of heath and of coarſe graſſes, and in a few months render the ſoil extremely friable. Lime has the effect of utterly deſtroying heath, and of converting it into a valuable manure. Economy in the uſe of this ingredient, therefore, is extremely miſapplied. Accordingly, ſome ſkilful farmers lay one doſe of lime upon the land before it is ploughed, and another after it, that the furrow-ſlices and the whole tops and roots of the heath and other plants being wholly ſurrounded by this cauſtic ingredient, may be ſooner reduced into a ſtate of friable mould.

In ſpring, after the froſt is over, a ſlight harrowing will fill up all the interſtices in the furrows with mould to keep out the air and rot the turf or ſod. Thus the land may be ſuffered to lie during the following ſummer and winter, which will tend more to rot this kind of mooriſh turf than if it had been laid open to the air by ploughing. Next April let it be croſs-ploughed, braked, and harrowed, till it be ſufficiently pulverized for turnip-ſeed; at the ſame time, as much manure as can poſſibly be obtained ought to be given to it, and the manure mixed with the ſoil.

Swampy lands, and a ſoil covered with ruſhes, ant-hills, and coarſe graſſes, may be treated advantageouſly in a manner ſomewhat different. Where lime is to be found in abundance, it is proper to pare the ſurface,

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and to collect the whole turf into heaps in different parts of the field, and make it up into compoſt with lime. The whole heaps in ſuch caſes ought to be thoroughly moiſtened, and the maſs to be well turned and mixed. In this way all the roots and coarſe herbage will be deſtroyed, and gradually reduced into a moſt valuable manure, for enriching the ſoil over which it ought to be ſpread, and thereafter ploughed in.

The ſecond mode of improving waſte lands of every kind is by paring and burning the ſurface. When land is pared, a thin ſod is taken off, either by a paring ſpade, or paring plough, over the whole ſurface. The ſods being dried, are collected into ſmall heaps and burnt, and the aſhes are ſcattered over the field. This practice has been found ſo obviouſly uſeful in the firſt inſtance, at leaſt, that it has been extended by many farmers to all ſoils upon breaking them up from graſs, though formerly cultivated and in good order, eſpecially where lime cannot eaſily be obtained. At the ſame time, as the propriety of the practice is ſtill greatly diſputed, it may be proper to adopt this opportunity of taking ſome general notice of the ſubject. By one ſet of writers, ſays the Rev. Mr Arthur Young *, the practice is pronounced to be contrary to every principle; that it is a waſteful extravagant operation which diſſipates what ſhould be retained, annihilates oils and mucilage, calcines ſalts, and reduces fertile organic matter into aſhes of very weak efficacy; that the vegetable particles which are brought into play at once for the production of a ſingle crop, by leſs deſperate management, might

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* *Communications to the Board of Agriculture*, vol. ii.

paration Land. might be huſbanded to the ſupport of many. On the contrary, the advocates for this operation aſſert that theſe objections are all founded on vain reaſoning and ſpeculative theory; that practice the moſt decided, and experience the moſt extended, pronounce it to be an admirable ſyſtem; and that the miſchiefs often quoted as flowing from it are to be attributed merely to the abuſe of the method, and are by no means neceſſarily connected with it.

"I muſt without the leaſt heſitation declare, ſays this writer, that the latter of theſe opinions is that to which I ſubſcribe. To truſt to reaſoning in matters of agriculture is a moſt dangerous reliance: I ſhall leave others to detail their philoſophical ſpeculations, and reſt what I have to offer ſolely on the practice, various and extenſive, of numerous agriculturiſts, and on the common huſbandry of many ſpacious diſtricts.

"Theſe agree in declaring (and it is moſt particularly to be had in remembrance, for the enemies of the practice admit it), that by paring and burning you may command two or three good corn crops in ſucceſſion. The fact cannot be denied; for whether you examine the peat of the Cambridgeſhire fens, or the fallow chalk ſoils of the downs and wolds of Hampſhire, Glouceſterſhire, or the eaſt riding of Yorkſhire, it is known that bad farmers do act thus abſurdly; they get indeed great crops, but they too often take them in ſucceſſion, to the injury of the ſoil, though not to its ruin, unleſs that can be eſteemed the ruin of land, which enables the tenant to pay double rent for it. Such farmers have been in the habit of burning for wheat, and then taking two crops of ſpring-corn, all good. Now it might be aſked, how is it poſſible that that huſbandry can produce all the evils detailed above, which enables a ſoil naturally poor and weak to give two or three good crops of corn? Their argument evidently proves too much; the effect ſhows that there is a powerful cauſe or agent in burning which they do not underſtand, which eſcapes from the retort of the chemiſt, and from the *rationale* of the theoriſt. That operation or manure which will give a good crop of wheat will give a good crop of turnip or cabbage; and he who, having made this commencement for the food of ſheep on the land, and knows not how to go on, preſerving the advantage he has gained, is a novice in the art of huſbandry. The farmers that are railed at know it as well as their philoſophical inſtructors; but avarice, united with the baneful effect of ſhort or no leaſes, makes them practiſe againſt their judgments.

" Paring and burning will on all ſorts of land give turnip or cabbage; theſe fed on the land by ſheep, will ſecure barley or oats, and ſeeds; the ſeeds, fed with ſheep, whether for a ſhort or a longer duration, will ſecure another crop of corn adapted to the ſoil; and in this ſtage of the progreſs, the ſoil will have gained much more than it has loſt. To inſtance caſes which I have ſeen, and quote authorities for theſe aſſertions, would be tireſome. I can aſſure the Board, that inſtances might be produced from more than half the counties of the kingdom.

" It has often been contended, that burning leſſens the ſoil. If this happen any where, it muſt be in peat: yet in the fens of Cambridgeſhire this huſbandry has been repeated once in eight years for a century and a half; and the proofs of a loſs of depth are extremely vague in every inſtance I have met with, and hardly to eparation of Land.

be diſtinguiſhed from that undoubted ſubſidence which takes place in drained bogs of every deſcription. In all other ſoils the aſſertion may be ſafely and poſitively denied: I have calcined pared turf, not calcareous, after careful ſeparation and weighing, and in a heat far exceeding what is ever given in burning in the field, and, reweighing, found the loſs too minute to attribute to any thing but loſs of water intimately combined, but driven off by heat; and re-expoſing the earth to the atmoſphere free from rain, found an increaſe rather than a diminution of weight. The vegetable particles only are reduced to aſhes: theſe, in any method of putrefaction, would diſſolve; and combining with water, be exhaled by heat or abſorbed by the veſſels of plants. In aſhes theſe are in a more fixed ſtate relatively to the influences of the atmoſphere; and that plants feed on them, the great crops which ſucceed offer abundant proof.

" In addition to theſe circumſtances is the capital one of deſtroying inſects, grubs, and weeds: theſe are apt to abound moſt in the richer ſoils; no reaſon for abſtaining from this huſbandry on ſuch.

" I venture, therefore, to conclude, that paring and burning with a proper courſe of crops, is ſafe on any ſoil, and eſſentially neceſſary on ſome, as I ſhall preſently ſhew.

" *Clay.*—The gentlemen who have objected to paring and burning, have not given many reaſons peculiarly appropriate to this ſoil; the only one that merits the leaſt attention is, the aſſertion, that it converts what is properly ſoil into pieces of unfertile brick: the fact is not ſo; for every one who has burnt clay for *manure* knows, that though there be many lumps of the ſubſtance which they allude to, yet that the maſs of the heap conſiſts of aſhes, properly ſo called; but when the tenacity of this ſoil is conſidered (which is one of its greateſt evils), it will be found, that bricks are an excellent addition to the ſoil, to looſen and open its ſtubborn adheſion.

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"Heaps of clay-aſhes, amounting to many hundreds of loads, have been burnt, and applied to great profit on this ſoil. By paring and burning, therefore, you have on it the common manure found in vegetable aſhes; and you have in addition a ſubſtance which acts mechanically. Hitt, who wrote from practice, and abounds with many juſt obſervations, remarks, 'I recommend burning of the ſurface as the cheapeſt manure, and moſt effectual of any; for it not only adds ſalts to the ſoil (which the burning of graſs roots produces) but it opens part of the ſtratum of clay next the ſoil ſo much that the roots of vegetables can afterwards feed therein; for when the turf of a piece of land has been burnt in heaps at four or five yards apart, though all the aſhes be taken away with ſome of the earth, and ſpread over the other parts of the land; yet neither corn nor turnips will grow ſo vigorouſly there, as on thoſe places that were only opened by heat."

Even upon good loams, on which the practice is moſt condemned, this writer ſupports it upon the authority of his own experience, as well as upon the experience of ſome reſpectable farmers. With regard to ſandy ſoils, he alleges that he has ſeen them alſo improved by it in Suffolk and in Cambridgeſhire. With regard to chalk, he obſerves, that it is the common method of breaking up downs in every part of England. On the Cottiſwold hills in Glouceſterſhire, it is the common

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mon huſbandry, and often repeated. In Hampſhire and Warwickſhire the ſame huſbandry prevails, and the ſheep walks and warrens on the wolds of the eaſt riding of Yorkſhire and of Lincolnſhire have thus been brought moſt profitably into culture. With regard to peat, he ſtates, that "whatever variety of ſentiments there may be for this method on other ſoils, here there can be none. The univerſal practice from the flat fens of Cambridgeſhire to the ſwelling bogs of Ireland, on the mountainous moors on the north of England, and on the rough ſedgy bottoms in almoſt every part of the kingdom, when freſh lands are broken up by men of real practice and obſervation, is to begin by paring and burning.""

The following remarks upon the ſubject, in the Report of the Agriculture of the county of Northumberland, by J. Bayley and G. Culley, are worthy of attention. "Paring and burning is not much practiſed in the eaſtern and northern parts of the county: in the middle and ſouthern parts it is moſt prevalent; but, even there, it is confined to old ſwards, and coarſe, rough, ruſhy, and heathy lands. For the firſt breaking up of ſuch ground, it is certainly very convenient, and preferable to any other mode we have ever ſeen; but though we are fully convinced of its beneficial effects in ſuch ſituations, yet we have our doubts whether it could be uſed with advantage upon lands that have lain a few years in graſs, and that would produce good crops of grain immediately on being ploughed out, which is not the caſe with coarſe rough heathy lands, or even very old ſwards on rich fertile ſoils; it being found that crops on the latter are frequently very much injured by *leaping* for two or three years, which paring and burning entirely obviate, and enſure full crops to the farmer,

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mer, who need not be under any apprehenſion of his ſoil being ruined by it, provided he purſue the following courſe: 1. Turnips; 2. Oats; 3. Fallow well limed for turnips; 4. Barley ſown up with clover and graſs ſeeds, and depaſtured with ſheep for three or four years. It is the injudicious cropping, more than the ill effects derived from paring and burning, that has been the chief cauſe of bringing ſuch an odium on this practice, which is certainly an excellent one in ſome ſituations, and when properly conducted; but, like the fermented juice of the grape, may be too often repeated and improperly applied.

"The popular clamour againſt this practice, "that it deſtroys the ſoil," we can by no means admit; and are inclined to believe, that not a ſingle atom of ſoil is abſtracted, though the bulk of the ſod or turf be diminiſhed. This ariſes from the burning of the roots or vegetable ſubſtances, which, by this proceſs, afford a conſiderable portion of alkaline ſalts, phlogiſtic or carbonic matter, and probably other principles friendly to vegetation; as we find thoſe aſhes produce abundant crops of turnips, which fatten ſtock much quicker than thoſe after any other dreſſing or manure we have ever ſeen; and the ſucceeding crops of corn are ſo very luxuriant as to tempt the injudicious cultivator to purſue it too far; who, for the ſake of a temporary gain, may be ſaid to rip it up, as the boy did his gooſe that laid golden eggs."

In the Annals of Agriculture various inſtances are exhibited of the ſucceſsful uſe of this practice, as well as of the abuſe of it. In one paper upon the ſubject * the

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* Vol. xxviii.

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the editor himſelf remarks, when ſpeaking of a diſtrict of Hampſhire which he ſurveyed, that "the argument commonly heard is, that it leſſens the ſtaple of a thin ſoil: but facts are clear againſt this; for if it were true, there are ſoils that would have been much more than leſſened, for they would have been all gone centuries ago. The practice is known to have been of great antiquity, and not to be executed but in proportion as a *turf* is formed; the preſident de la Tour d'Aigues ſhowed me lands in Provence that had been pared and burnt probably for 2000 years, and he juſtly ridiculed the idea of waſting the ſoil. The queſtion is, whether you ſhall rot or burn the vegetable particles? and that method is apparently the beſt which produces the beſt crops. Every man with his eyes open, in this country, will ſee the crops given by paring; the practice is the baſis of all the good crops I have ſeen, and they have many that would do credit to much richer countries."

John Dalton, Eſq. an experienced agriculturiſt, in a communication addreſſed to the Board of Agriculture *, expreſſes himelf thus: "The beſt method I ever found of converting graſs-land into tillage is unqueſtionably by paring and burning: you get into a good courſe of huſbandry at once, turnips, barley, &c. &c. and it is a mere chimera to ſuppoſe that the ſoil is diminiſhed by it. I have myſelf pared and burned the ſame field twice in the courſe of 15 years, and could never diſcover that the ſoil was in the ſmalleſt degree diminiſhed by the operation."

Upon

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* *Communic.* vol. iii.

General opinion as to paring and burning.

Upon the whole, whatever judgment may be pronounced with regard to the practice of paring and burning, when applied to lands which have been previouſly cultivated, there appears to be no doubt, that it is the beſt of all modes of breaking up a freſh, rude, and hitherto untouched ſoil. The only hazard in the performance of it is, that the men accuſtomed to the work rarely cut deep enough on peaty ſoils to deſtroy the ling root and branch. It is better, when practicable, to plough and burn the furrow; and, when not practicable, to add ſomething to the common price for having the work done to a greater depth. The effect of this operation is prodigious on theſe ſoils; it deſtroys the ſpontaneous growth quicker and more effectually than any other method: a whole year's tillage and fallowing are inferior in this reſpect. It furniſhes a manure which is very well adapted to the nature of the ground; for it has been found on abundance of trials, that no manure exceeds the aſhes of chimnies in mountainous countries wherein the ſurface of thoſe mountains is the fuel of the people; a fact that holds true in proportion to the depth to which they are dug; the aſhes of the pure *heavy* black bog being the beſt of all. But the ſingular advantage of this mode of breaking up is the ſuddenneſs with which a black moor becomes green under a flouriſhing crop of cabbage, rape, or turnip. It may be burnt in a north-eaſt drying wind, in the ſpring, and in July covered with uſeful vegetation.

It is believed, that the practice of paring and burning was originally introduced in ſituations in which lime or proper fuel for burning limeſtone could not readily be obtained. It is obſerved, however, by a judicious wri-

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ter in the Annals of Agriculture*, that "experience has proved that the addition of lime to the aſhes of the pared ſurface operates more beneficially than if ſpread in any other manner. The larger the quantity, the greater the effect, and probably the greater the *proportional* effect; that is, ſix chaldrons an acre will do more than twice the good of three chaldrons; the chemical effect both in neutralizing the acids found in all theſe ſoils, and alſo in deſtroying the roots left of the ſpontaneous growth depending in ſome meaſure on the effect taking place ſuddenly. It has been known, that eight chaldrons an acre laid on at once, have converted a moor to meadow worth 25s. an acre; but the ſame moor under one chaldron per acre per annum for eight years, has not been worth 7s. 6d. an acre. The effect of lime on all ſoils long in cultivation is problematical, and does not anſwer the expence in one caſe in ten; but in new moor lands, the effect is prodigious and hardly credible. Laid on ling mountains without tillage, without paring, or other operation than merely cutting the ling, and ſpreading the lime, ſuch moors have been changed from 1s. to 20s. per acre; but the quantity has been 15 and 20 chaldrons per acre. The beſt guide in laying on lime is the expence; a prudent man would be cautious of going further than 40s. an acre, and at the extreme 3l.; even at 40s. the total expence of the improvement will run high."

After paring and burning when the aſhes are ſpread, which is ſuppoſed to be in the month of May, the field ſhould be ploughed true, but ſhallow, in order not to bury

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* Vol. xx.

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bury the aſhes too deep; then harrowed very well till ſine) and ploughed ſhallow again croſs. This, with a ſecond good harrowing, will mix and incorporate the ſoil and aſhes ſo well, that it is ſcarcely poſſible to miſs a crop of turnips if any rain at all fall during the month of June.

Courſe of crops for improving waſte lands.

The moſt important point in all attempts to improve waſte lands, conſiſts of adopting a proper courſe of crops after the land is broke up. This is indeed the keyſtone of the arch; and if this object be not attended to with ſingular care, and correct views adopted concerning it, the whole improvement will infallibly fail in profit, and perhaps prove a ruinous ſpeculation. It ought to be obſerved then, that although the uſe of lime, or of paring and burning with or without the addition of lime, may do much towards the temporary production of crops upon a new ſoil, yet that ſuch ſtimulating manures muſt not be relied on as ſources of permanent fertility. The great object, therefore, with every improver of lands, ought to be to conſider well in what manner he may moſt readily obtain the command of large quantities of dung, for the purpoſe of putting the ſoil truly and ſubſtantially into good heart or condition. If this is not done, he has only exchanged bad graſs for bad crops, and has obtained no real advantage by the change. That courſe of crops, therefore, ought to be adopted, which affords the moſt abundant ſubſiſtence for a great number of cattle or of ſheep. With this view, turnips are the readieſt reſource, becauſe they ſucceed well upon a new ſoil, with little or no dung. The turnip crop, therefore, which ought always to be the firſt after breaking up, may be wholly conſumed upon the ſoil by ſheep or calves;

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calves: the land will thus be enriched by their dung with little trouble or expence. The benefit ariſing from this mode of proceeding is ſo great, that it ought not to terminate with a ſingle year, but ought to be followed by another crop of turnips during the ſecond year, to be conſumed upon the land in like manner; and ſome improvers have even advantageouſly proceeded the length of taking a third crop of turnips, though probably it might prove more advantageous, as the land is new dunged, to take a crop of cabbages during the third year, always remembering, that the whole dung produced by the cattle fed upon this crop, ought to be reſtored to the new ſoil. After theſe green crops, the land will be in excellent condition for laying down with graſs ſeeds. The moſt correct mode of ſowing graſs ſeeds, in ſuch a caſe, no doubt, is to put upon the ground no other crop at the ſame time with themſelves; but, as barley ſucceeds extremely well after turnips, and is, at the ſame time, in other reſpects, the kind of grain that is moſt advantageouſly uſed along with graſs ſeeds, a crop of barley thinly ſown may be taken at the ſame time.

If the land that has thus been brought under the plough forms part of a cold, bleak, and mountainous region, the beſt plan that can be adopted for rendering it profitable, is that which brings it moſt ſpeedily and perfectly into condition to become a valuable paſture for ſheep. When this, therefore, is the object in view, which in all ſuch ſituations it ought to be, rye-graſs need not be uſed as one of the graſs ſeeds; and, at all events, a crop of hay ought not to be taken, as this would tend to exhauſt the ſoil, and to retard the ſpeedy formation of a cloſe and rich paſture. If the lands, however, are in

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in ſuch a ſituation, that they may be expected to be uſed with advantage for the frequent production of crops of grain, a crop of hay may be taken as increaſing the quantity of food for cattle, and thereby giving an additional command of manure; and the land may, after another year or two, be reſtored to tillage.

5. *Forming Ridges.*

Of ridges.

The firſt thing that occurs on this head, is to conſider what grounds ought to be formed into ridges, and what ought to be tilled with a flat ſurface. Dry ſoils, which ſuffer by lack of moiſture, ought to be tilled flat, which tends to retain moiſture. And the method for ſuch tilling, is to go round and round from the circumference to the centre, or from the centre to the circumference. This method is advantageous in point of expedition, as the whole is finiſhed without once turning the plough. At the ſame time, every inch of the ſoil is moved, inſtead of leaving either the crown or the furrow unmoved, as is commonly done in tilling ridges. Clay ſoil, which ſuffers by water ſtanding on it, ought to be laid as dry as poſſible by proper ridges. A loamy ſoil is the middle between the two mentioned. It ought to be tilled flat in a dry country, eſpecially if it incline to the ſoil firſt mentioned. In a moiſt country, it ought to be formed into ridges, high or low according to the degree of moiſture and tendency to clay.

Evils attending to high ridges

In grounds that require ridging, an error prevails, that ridges cannot be raiſed too high. High ridges labour under ſeveral diſadvantages. The ſoil is heaped upon the crown, leaving the furrows bare: the crown is too dry, and the furrows too wet: the crop, which reparation of Land.

is always beſt on the crown, is more readily ſhaken with the wind, than where the whole crop is of an equal height; the half of the ridge is often covered from the ſun, a diſadvantage which is far from being ſlight in a cold climate. High ridges labour under another diſadvantage, in ground that has no more level than barely ſufficient to carry off water: they ſink the furrows below the level of the ground; and conſequently retain water at the end of every ridge. The furrows ought never to be ſunk below the level of the ground. Water will more effectually be carried off by leſſening the ridges both in height and breadth: a narrow ridge, the crown of which is but 18 inches higher than the furrow, has a greater ſlope than a very broad ridge, where the difference is three or four feet.

idges on eclivities.

Next, of forming ridges where the ground hangs conſiderably. Ridges may be too ſteep as well as too horizontal: and if to the ridges be given all the ſteepneſs of a field, a heavy ſhower may do irreparable miſchief. To prevent ſuch miſchief, the ridges ought to be ſo directed croſs the field, as to have a gentle ſlope for carrying off water ſlowly, and no more. In that reſpect, a hanging field has greatly the advantage of one that is nearly horizontal; becauſe, in the latter, there is no opportunity of a choice in forming the ridges. A hill is of all the beſt adapted for directing the ridges properly. If the ſoil be gravelly, it may be ploughed round and round, beginning at the bottom and aſcending gradually to the top in a ſpiral line. This method of ploughing a hill requires little more force than ploughing on a level; and at the ſame time removes the great inconvenience of a gravelly hill, that rains go off too quickly; for the rain is retained in

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every furrow. If the ſoil be ſuch as to require ridges, they may be directed to any ſlope that is proper.

Crooked ridges.

In order to form a field into ridges that has not been formerly cultivated, the rules mentioned are eaſily put in execution. But what if ridges be already formed, that are either crooked or too high? After ſeeing the advantage of forming a field into ridges, people were naturally led into an error, that the higher the better. But what could tempt them to make their ridges crooked? Certainly this method did not originate from deſign; but from the lazineſs of the driver ſuffering the cattle to turn too haſtily, inſtead of making them finiſh the ridge without turning. There is more than one diſadvantage in this ſlovenly practice. Firſt, the water is kept in by the curve at the end of every ridge, and ſours the ground. Next, as a plough has the leaſt friction poſſible in a ſtraight line, the friction muſt be increaſed in a curve, the back part of the mouldboard preſſing hard on the one hand, and the coulter preſſing hard on the other. In the third place, the plough moving in a ſtraight line, has the greateſt command in laying the earth over. But where the ſtraight line of the plough is applied to the curvature of a ridge in order to heighten it by gathering, the earth moved by the plough is continually falling back, in ſpite of the efforts of the moſt ſkilful ploughman.

Altering ridges.

The inconveniences of ridges high and crooked are ſo many, that one would be tempted to apply a remedy at any riſk. And yet, if the ſoil be clay, it would not be adviſable for a tenant to apply the remedy upon a leaſe ſhorter than two nineteen years. In a dry gravelly ſoil, the work is not difficult nor hazardous.

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When the ridges are cleaved two or three years ſucceſſively in the courſe of cropping, the operation ought to be concluded in one ſummer. The earth, by reiterated ploughings, ſhould be accumulated upon the furrows, ſo as to raiſe them higher than the crowns: they cannot be raiſed too high, for the accumulated earth will ſubſide by its own weight. Croſs ploughing once or twice, will reduce the ground to a flat ſurface, and give opportunity to form ridges at will. The ſame method brings down ridges in clay ſoil: only let care be taken to carry on the work with expedition; becauſe a hearty ſhower, before the new ridges are formed, would ſoak the ground in water, and make the farmer ſuſpend his work for the remainder of that year at leaſt. In a ſtrong clay, we would not venture to alter the ridges, unleſs it can be done to perfection in one ſeaſon. On this ſubject Dr Anderſon has the following obſervations *.

Inconveniences in the common methods of levelling.

"The difficulty of performing this operation properly with the common implements of huſbandry, and the obvious benefit that accrues to the farmer from having his fields level, has produced many new inventions of ploughs, harrows, drags, &c. calculated for ſpeedily reducing the fields to that ſtate; none of which have as yet been found fully to anſwer the purpoſe for which they were intended, as they all indiſcriminately carry the earth that was on the high places into thoſe that were lower; which, although it may in ſome caſes render the ſurface of the ground tolerably ſmooth and level, is uſually attended with inconveniences far

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* *Eſſays on Agriculture*, vol. i. p. 146.

far greater, for a conſiderable length of time, than that which it was intended to remove.

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Vegetable mould becomes inert by being long buried

"For experience ſufficiently ſhows, that even the beſt vegetable mould, if buried for any length of time ſo far beneath the ſurface as to be deprived of the benign influences of the atmoſphere, loſes its *vis vitæ*, if I may be allowed that expreſſion; becomes an inert lifeleſs maſs, little fitted for nouriſhing vegetables; and conſtitutes a ſoil very improper for the purpoſes of the farmer. It therefore behoves him, as much as in him lies, to preſerve, on every part of his fields, an equal covering of that vegetable mould that has long been uppermoſt, and rendered fertile by the meliorating influence of the atmoſphere. But, if he ſuddenly levels his high ridges by any of theſe mechanical contrivances, he of neceſſity buries all the good mould that was on the top of the ridges in the old furrows; by which he greatly impoveriſhes one part of his field, while he too much enriches another; inſomuch that it is a matter of great difficulty, for many years thereafter, to get the field brought to an equal degree of fertility in different places; which makes it impoſſible for the farmer to get an equal crop over the whole of his field by any management whatever: and he has the mortification frequently, by this means, to ſee the one half of his crop rotted by an over-luxuriance, while other parts of it are weak and ſickly, or one part ripe and ready for reaping, while the other is not properly filled; ſo that it were, on many occaſions, better for him to have his whole field reduced at once to the ſame degree of poorneſs as the pooreſt of it, than have it in this ſtate. An almoſt impracticable degree of attention in ſpreading the manures may indeed in ſome meaſure get the better

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better of this: but it is ſo difficult to perform this properly, that I have frequently ſeen fields that had been thus levelled, in which, after thirty years of continued culture and repeated dreſſings, the marks of the old ridges could be diſtinctly traced when the corn was growing, although the ſurface was ſo level that no traces of them could be perceived when the corn was off the ground.

" But this is a degree of perfection in levelling that cannot be uſually attained by following this mode of practice; and, therefore, is but ſeldom ſeen. For all that can be expected to be done by any levelling machine, is to render the ſurface perfectly ſmooth and even in every part, at the time that the operation is performed: but as, in this caſe, the old hollows are ſuddenly filled up with looſe mould to a great depth, while the earth below the ſurface upon the heights of the old ridges remains firm and compact, the new raiſed earth after a ſhort time ſubſides very much, while the other parts of the field do not ſink at all; ſo that in a ſhort time the old furrows come to be again below the level of the other parts of the field, and the water of courſe is ſuffered in ſome degree to ſtagnate upon them; inſomuch that, in a few years, it becomes neceſſary once more to repeat the ſame levelling proceſs, and thus renew the damage that the farmer ſuſtains by this pernicious operation.

Levelling ſometimes not to be attempted.

" On theſe accounts, if the farmer has not a long leaſe, it will be found in general to be much his intereſt to leave the ridges as he found them, rather than to attempt to alter their direction; and, if he attends with due caution to moderate the height of theſe old ridges, he may reap very good crops, although perhaps at a ſomewhat greater expence of labour, than he would have been put to upon the ſame field, if it had been reduced to a proper level ſurface, and divided into ſtraight and parallel ridges.

But, where a man is ſecure of poſſeſſing his ground for any conſiderable length of time, the advantages that he will reap from having level and well laid out fields, are ſo conſiderable as to be worth purchaſing, if it ſhould be even at a conſiderable expence. But the loſs that is ſuſtained at the beginning, by this mechanical mode of levelling ridges, if they are of conſiderable height, is ſo very great, that it is perhaps doubtful if any future advantages can ever fully compenſate it. I would therefore adviſe, that all this levelling apparatus ſhould be laid aſide; and the following more efficacious practice be ſubſtituted in its ſtead: A practice that I have long followed with ſucceſs, and can ſafely recommend as the very beſt that has yet come to my knowledge.

Beſt method of levelling.

“ If the ridges have been raiſed to a very great height, as a preparation for the enſuing operations, they may be firſt *cloven*, or *ſcalded* out, as it is called in different places; that is, ploughed ſo as to lay the earth on each ridge from the middle towards the furrows. But if they are only of a moderate degree of height, this operation may be omitted. When you mean to proceed to level the ground, let a number of men be collected, with ſpades, more or fewer as the nature of the ground requires, and then ſet a plough to draw a furrow directly acroſs the ridges of the whole field intended to be levelled. Divide this line into as many parts as you have labourers, allotting to each one ridge or two, or more or leſs, according to their number,

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number, height, and other circumſtances. Let each of the labourers have orders, as ſoon as the plough has paſſed that part aſſigned him, to begin to dig in the bottom of the furrow that the plough has juſt made, about the middle of the ſide of the old ridge, keeping his face towards the old furrow, working backwards till he comes to the height of the ridge; and then turn towards the other furrow, and repeat the ſame on the other ſide of the ridge, always throwing the earth that he digs up into the deep old furrow between the ridges, that is directly before him; taking care not to dig deep where he firſt begins, but to go deeper and deeper as he advances to the height of the ridge, ſo as to leave the bottom of the trench he thus makes acroſs the ridge entirely level, or as nearly ſo as poſſible. And when he has finiſhed that part of the furrow allotted to him that the plough has made in going, let him then go and finiſh in the ſame manner his own portion of the furrow that the plough makes in returning. In this manner, each man performs his own taſk through the whole field, gradually raiſing the old furrows as the old heights are depreſſed. And, if an attentive overſeer is at hand, to ſee that the whole is equally well done, and that each furrow is raiſed to a greater height than the middle of the old ridges, ſo as to allow for the ſubſiding of that looſe earth, the operation will be entirely finiſhed at once, and never again need to be repeated.

" In performing this operation, it will always be proper to make the ridges, formed for the purpoſe of levelling, which go acroſs the old ridges, as broad as poſſible; becauſe the deep trench that is thus made in each of the furrows is an impediment in the future operations,

tions, as well as the height that is accumulated in the middle of each of theſe ridges; ſo that the fewer there are of theſe, the better it is. The farmer, therefore, will do well to advert to this in time, and begin by forming a ridge by always turning the plough to the right hand, till it becomes of ſuch a breadth as makes it very inconvenient to turn longer in that manner; and then, at the diſtance of twice the breadth of this new-formed ridge from the middle of it, mark off a furrow for the middle of another ridge, turning round it to the right hand, in the ſame manner as was done in the former, till it becomes of the ſame breadth with it; and then, turning to the left hand, plough out the interval that was left between the two new-formed ridges. By this mode of ploughing, each ridge may be made of 40, 50, or 60 yards in breadth, without any great inconvenience; for although ſome time will be loſt in turning at the ends of theſe broad ridges, yet as this operation is only to be once performed in this manner, the advantage that is reaped by having few open furrows, is more than ſufficient to counterbalance it. And, in order to moderate the height that would be formed in the middle of each of theſe great ridges, it will always be proper to mark out the ridges, and draw the furrow that is to be the middle of each, ſome days before you collect your labourers to level the field; that you may, without any hurry or loſs of labour, clear out a good trench through the middle of each of the old ridges; as the plough, at this time, going and returning nearly in the ſame track, prevents the labourers from working properly without this precaution.

"If theſe rules are attended to, your field will be at once reduced to a proper level, and the rich earth that formed

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formed the ſurface of the old ridges be ſtill kept upon the ſurface of your field; ſo that the only loſs that the poſſeſſor of ſuch ground can ſuſtain by this operation, is merely the expence of performing it."

Dr Anderſon afterwards makes a calculation of the different expences of levelling by the plough and by the ſpade, in which he finds the latter by far the cheapeſt method.

Proper direction of the ridges.

Let it be a rule to direct the ridges north and ſouth, if the ground will permit. In this direction, the eaſt and weſt ſides of the ridges, dividing the ſun equally between them, will ripen at the ſame time.

Narrow ridges an advantage.

It is a great advantage in agriculture, to form ridges ſo narrow, and ſo low, as to admit the crowns and furrows to be changed alternately every crop. The ſoil neareſt the ſurface is the beſt; and by ſuch ploughing, it is always kept near the ſurface, and never buried. In high ridges, the ſoil is accumulated at the crown and the furrows left bare. Such alteration of crown and furrow is eaſy where the ridges are no more but ſeven or eight feet broad. This mode of ploughing anſwers perfectly well in ſandy and gravelly ſoils, and even in loam; but it is not ſafe in clay ſoil. In that ſoil, the ridges ought to be 12 feet wide, and 20 inches high; to be preſerved always in the ſame form by caſting, that is, by ploughing two ridges together, beginning at the furrow that ſeparates them, and ploughing round and round till the two ridges be finiſhed. By this method, the ſeparating furrow is raiſed a little higher than the furrows that bound the two ridges. But at the next ploughing, that inequality is corrected, by beginning at the bounding furrows, and going

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round and round till the ploughing of the two ridges be completed at the ſeparating furrow.

6. *Of Cleaning Ground.*

Cleaning harrow. Plate IV. fig. 5.

—For this purpoſe a new inſtrument, termed a *cleaning harrow*, has been introduced by Lord Kaimes, and is ſtrongly recommended *. It is one entire piece like the firſt of thoſe mentioned above, conſiſting of ſeven bulls, four feet long each, two and one-fourth inches broad, two and three-fourths deep. The bulls are united together by ſheths, ſimilar to what were mentioned above. The intervals between the bulls being three and three-fourths inches, the breadth of the whole harrow is three feet five inches. In each bull are inſerted eight teeth, each nine inches free below the wood, and diſtant from each other ſix inches. The weight of each tooth is a pound, or near it. The whole is firmly bound by an iron plate from corner to corner in the line of the draught. The reſt as in the harrows mentioned above. The ſize, however, is not invariable. The cleaning harrow ought to be larger or leſs according as the ſoil is ſtiff or free.

To give this inſtrument its full effect, ſtones of ſuch a ſize as not to paſs freely between the teeth ought to be carried off, and clods of that ſize ought to be broken. The ground ought to be dry, which it commonly is in the month of May.

In preparing for barley, turnip, or other ſummer-crop, begin with ploughing and croſs ploughing. If the

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* In his *Gentleman Farmer*; to which performance the practical of this treatiſe is materially indebted.

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Plate IV. fig. 1. 2. 3.

the ground be not ſufficiently pulverized, let the great brake be applied, to be followed ſucceſſively with the 1ſt and 2d harrows. In ſtiff ſoil, rolling may be proper, once or twice between the acts. Theſe operations will looſen every root, and bring ſome of them to the ſurface. This is the time for the 3d harrow, conducted by a boy mounted on one of the horſes, who trots ſmartly along the field, and brings all the roots to the ſurface: there they are to lie for a day or two, till perfectly dry. If any ſtones or clods remain, they muſt be carried off in a cart. And now ſucceeds the operation of the cleaning harrow. It is drawn by a ſingle horſe, directed by reins, which the man at the oppoſite corner puts over his head, in order to have both hands free. In this corner is fixed a rope, with which the man from time to time raiſes the harrow from the ground, to let the weeds drop. For the ſake of expedition, the weeds ought to be dropt in a ſtraight line croſs the field, whether the harrow be full or not; and ſeldom is a field ſo dirty, but that the harrow may go 30 yards before the teeth are filled. The weeds will be thus laid in parallel rows, like thoſe of hay raked together for drying. A harrow may be drawn ſwiftly along the rows, in order to ſhake out all the duſt; and then the weeds may be carried clean off the field in carts. But we are not yet done with theſe weeds; inſtead of burning, which is the ordinary practice, they may be converted into uſeful manure, by laying them in a heap with a mixture of hot dung to begin fermentation. At firſt view, this way of cleaning land will appear operoſe; but, upon trial, neither the labour nor expence will be found immoderate. At any rate, the labour and expence ought

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not to be grudged; for if a field be once thoroughly cleaned, the ſeaſons muſt be very croſs, or the farmer very indolent, to make it neceſſary to renew the operation in leſs than 20 years. In the worſt ſeaſons, a few years paſture is always under command; which effectually deſtroys triennial plants, ſuch as thiſtles and couch-graſs.

7. *On the Nature of different Kinds of Soils, and the Plants proper to each.*

Clay ſoil.

1. Clay, which is in general the ſtiffeſt of all ſoils, and contains an unctuous quality. But under the term *clays*, earths of different ſorts and colours are included. One kind is ſo obſtinate, that ſcarcely any thing will ſubdue it; another is ſo hungry and poor, that it abſorbs whatever is applied, and turns it into its own quality. Some clays are fatter than others, and the fatteſt are the beſt; ſome are more ſoft and ſlippery. But all of them retain water poured on their ſurface, where it ſtagnates, and chills the plants, without ſinking into the ſoil. The cloſeneſs of clay prevents the roots and fibres of plants from ſpreading in ſearch of nouriſhment. The blue, the red, and the white clay, if ſtrong, are unfavourable to vegetation. The ſtony and looſer ſorts are leſs ſo; but none of them are worth any thing till their texture is ſo looſened by a mixture of other ſubſtances, and opened, as to admit the influence of the ſun, the air, and froſts. Among the manures recommended for clay, ſand is of all others to be preferred; and ſea ſand is the beſt of all, where it can be obtained. This moſt effectually breaks the coheſion.

The reaſon for preferring ſea ſand is, that it is not

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formed wholly (as moſt other ſands are) of ſmall ſtones; but contains a great deal of calcareous matter in it, ſuch as ſhells grated and broken to pieces by the tide, and alſo of ſalts. The ſmaller the ſand is, the more eaſily it penetrates the clay; but it abides leſs time in it than the larger.

The next beſt ſand is that waſhed down by rains on gravelly ſoils. Thoſe which are dry and light are the worſt. Small gritty gravel has alſo been recommended by the beſt writers on agriculture for theſe ſoils; and in many inſtances we have found it to anſwer the purpoſe.

Shell marl, aſhes, and all animal and vegetable ſubſtances, are very good manures for clay; but they have been found moſt beneficial when ſand is mixed with them. Lime has been often uſed; but the writer of this ſection would not recommend it, for he never found any advantage from it ſingly, when applied to clays.

The crops moſt ſuitable for ſuch lands are, wheat, beans, cabbages, and rye-graſs. Clover ſeldom ſucceeds, nor indeed any plants whoſe roots require depth and a wide ſpread in the earth.

halky ſoil.

2. Chalk. Chalky ſoils are generally dry and warm, and if there be a tolerable depth of mould, fruitful; producing great crops of barley, rye, peaſe, vetches, clover, trefoil, burnet, and particularly ſainfoin. The latter plant flouriſhes in a chalky ſoil better than any other. But if the ſurface of mould be very thin, this ſoil requires good manuring with clay, marl, loam, or dung. As theſe lands are dry, they may be ſown earlier than others.

When your barley is three inches high, throw in

10lb.

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10lb. of clover, or 15lb. of trefoil, and roll it well. The next ſummer mow the crop for hay; feed off the aftermath with ſheep; and in winter give it a top-dreſſing of dung. This will produce a crop the ſecond ſpring, which ſhould be cut for hay. As ſoon as this crop is carried off, plough up the land, and, in the beginning of September, ſow three buſhels of rye per acre, either to feed off with ſheep in the ſpring or to ſtand for harveſt. If you feed it off, ſow winter vetches in Auguſt or September, and make them into hay the following ſummer. Then get the land into as fine tilth as poſſible, and ſow it with ſainfoin; which, with a little manure, once in two or three years, will remain and produce good crops for 20 years together.

Light poo ſoil.

3. Light poor land, which ſeldom produces good crops of any thing till well manured. After it is well ploughed, ſow three buſhels of buck-wheat, per acre, in April or May: When in bloom, let your cattle in a few days to eat off the beſt, and tread the other down; this done, plough in what remains immediately. This will ſoon ferment and rot in the ground; then lay it fine, and ſow three buſhels of rye per acre. If this can be got off early enough, ſow turnips; if not, winter vetches to cut for hay. Then get it into good tilth, and ſow turnip-rooted cabbages, in rows three feet apart. This plant ſeldom fails, if it has ſufficient room, and the intervals be well horſe-hoed; and you will find it the beſt ſpring feed for ſheep when turnips are over.

The horſe-hoeing will clean and prepare the land for ſainfoin; for the ſowing of which April is reckoned the beſt ſeaſon. The uſual way is to ſow it broad-caſt, four buſhels to an acre; but the writer

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prefers ſowing it in drills two feet aſunder; for then it may be horſe-hoed, and half the ſeed will be ſufficient.

The horſe-hoeing will not only clean the crop, but earth up the plants, and render them more luxuriant and laſting.

If you ſow it broad-caſt, give it a top-dreſſing in December or January, of rotten dung or aſhes, or, which is ſtill better, of both mixed up in compoſt.

From various trials, it is found that taking only one crop in a year, and feeding the after-growth, is better than to mow it twice. Cut it as ſoon as it is in full bloom, if the weather will permit. The hay will be the ſweeter, and the ſtrength of the plants leſs impaired, than if it ſtand till the ſeed is formed.

Light rich land.

4. Light rich land, being the moſt eaſy to cultivate to advantage, and capable of bearing moſt kinds of grain, pulſe, and herbage, little need be ſaid upon it. One thing, however, is very proper to be obſerved, that ſuch lands are the beſt adapted to the drill huſbandry, eſpecially where machines are uſed, which require ſhallow furrows to be made for the reception of the ſeed. This, if not prone to couch-graſs, is the beſt of all ſoils for lucerne; which, if ſown in two feet drills, and kept clean, will yield an aſtoniſhing quantity of the moſt excellent herbage. But lucerne will never be cultivated to advantage where couch-graſs and weeds are very plentiful; nor in the broad-caſt method, even where they are not ſo; becauſe horſe-hoeing is eſſential to the vigorous growth of this plant.

Coarſe rough land.

5. Coarſe rough land. Plough deep in autumn; when it has lain two weeks, croſs-plough it, and let it lie rough through the winter. In March give it another

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good ploughing; drag, rake, and harrow it well, to get out the rubbiſh, and ſow four buſhels of black oats per acre, if the ſoil be wet, and white oats if dry. When about four inches high, roll them well after a ſhower: This will break the clods; and the fine mould falling among the roots of the plants will promote their growth greatly.

Some ſow clover and rye-graſs among the oats, but this appears to be bad huſbandry. If you deſign it for clover, ſow it ſingle, and let a coat of dung be laid on in December. The ſnow and rain will then dilute its ſalts and oil, and carry them down among the roots of the plants. This is far better than mixing the crops on ſuch land, for the oats will exhauſt the ſoil ſo much, that the clover will be impoveriſhed. The following ſummer you will have a good crop of clover; which cut once, and feed the after-growth. In the winter plough it in, and let it lie till February: Then plough and harrow it well; and in March, if the ſoil be moiſt, plant beans in drills of three feet, to admit the horſe-hoe freely. When you horſe-hoe them a ſecond time, ſow a row of turnips in each interval, and they will ſucceed very well. But if the land be ſtrong enough for ſowing wheat as ſoon as the beans are off, the turnips may be omitted.

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SECT. I.

CULTURE OF PARTICULAR PLANTS.

THE articles hitherto inſiſted on, are all of them preparatory to the capital object of a farm, that of raiſing plants for the nouriſhment of man and of other animals. Theſe plants are of two kinds; culmiferous and leguminous; differing widely from each other. Wheat, rye, barley, oats, rye-graſs, are of the firſt kind: of the other kind are, peaſe, beans, clover, cabbage, and many others.

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us plants.

Culmiferous plants, ſays Bonnet, have three ſets of roots. The firſt iſſue from the ſeed, and puſh to the ſurface an upright ſtem; another ſet iſſue from a knot in that ſtem; and a third from another knot, nearer the ſurface. Hence the advantage of laying ſeed ſo deep in the ground as to afford ſpace for all the ſets.

gumi-
us plants.

Leguminous plants form their roots differently. Peaſe, beans, cabbage, have ſtore of ſmall roots, all iſſuing from the ſeed, like the undermoſt ſet of culmiferous roots; and they have no other roots. A potato and a turnip have bulbous roots. Red clover has a ſtrong tap-root. The difference between culmiferous and leguminous plants, with reſpect to the effects they produce in the ſoil, will be noticed afterwards, in the ſection concerning rotation of crops. As the preſent ſection is confined to the propagation of plants, it falls naturally to be divided into three articles: firſt, Plants cultivated for fruit; ſecond, Plants cultivated for roots; third, Plants cultivated for leaves.

Culture particul Plants

I. *Plants Cultivated for Fruit.*

1. WHEAT and RYE.

Anciently when the ſummer fallow was almoſt the only means employed for reſtoring the exhauſted fertility of the ſoil, this practice was univerſally adopted throughout Europe as a preparation for wheat. In France, excepting the Netherlands, the practice ſtill continues; and in our own country it is ſtill uſed to a conſiderable extent. The great loſs, however, both of time and labour, which is occaſioned by a ſummer fallow, has induced intelligent huſbandmen to make great exertions for the purpoſe of avoiding the neceſſity of it, as a preparation for this valuable but exhauſting crop. For this purpoſe, extraordinary tillage and extraordinary manure have been ſubſtituted for ſummer fallow. As it is found that wheat does not ſucceed ſo well, if ſown on land immediately after dunging, as it does when a previous crop is taken after the dung; an inducement has thereby been held out, to ſubſtitute to fallows thoſe green crops for which the drill huſbandry is beſt adapted. In the neighbourhood of Edinburgh, accordingly, a crop of potatoes is frequently made uſe of inſtead of a fallow; but, as potatoes greatly exhauſt the ſoil, this practice is only adopted in conſequence of the great command of manure which the neighbourhood of the city gives to the farmers. In other ſituations a leſs exhauſting crop muſt be uſed. Turnips, though otherwiſe ſuitable, are, in the general caſe, excluded, becauſe they cannot be advantageouſly conulture of articular Plants. ſumed till it is too late in the ſeaſon to ſow wheat. It has frequently been aſſerted, that of all the drilled crops, beans are moſt valuable as a preparation for wheat. An important experiment upon this ſubject was made by the duke of Grafton, of which an account is given in a letter from his grace to Mr Young, dated in Auguſt, 1799 *. "Being arrived at the eighth year of that experiment, which I undertook at your deſire, it appears to me that this may be a proper time to communicate to you the reſult of the trial.

"You will recollect, that the object was to find out, Whether that ſort of land uſually met with in the common fields of Northamptonſhire and the adjacent counties, would or would not bear alternately a crop of wheat, and then of beans, and *vice verſa* of beans, and then of wheat; after giving it, as in the open fields, a light dreſſing of muck, viz. from twelve to fifteen loads per acre every third year, without rendering the land poorer than when it was firſt undertaken. In order to aſcertain this point as accurately as poſſible, I pitched upon a field of moderate land, rather of a ſtiffiſh nature; better than the worſt, and much inferior to the beſt, in our open fields. The method I then purſued was the following: After having manured it in the manner ſpecified above, I ſowed the firſt year a moiety of the field with wheat, and the other part with beans; and every ſeaſon ſince I have been changing the crops, making them alternate from beans to wheat, and from wheat to beans each year, never having admitted a fallow.

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* *Annals of Agriculture*, vol. xxxiii.

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"It would give me more ſatisfaction if I could have furniſhed you with the meaſured particulars of each year's produce from both crops, but unluckily I have miſlaid the paper. I can only, therefore, relate from memory, that the difference between theſe crops, and thoſe of the ſame grain on other parts of the farm, was not ſuch, on an average of thoſe years, as would be worth regarding. The third and ſixth years, being the fartheſt from the mucking, were, of courſe, the worſt produce, though not remarkably ſo; and I will venture to pronounce, that the crops have kept up, on an average, with the ſeaſons, and have been but little inferior to the produce of the other fields on my farm. My farmer aſſures me, from accounts he has kept, that the beſt end of the land, has, on the average, yielded four quarters of wheat per acre, and the poorer end three quarters and a half. He is further of opinion, that the land, in point of heart, is neither improved nor worſe, for any agricultural purpoſe, than it was when firſt we began. According to my judgment, the courſe of huſbandry has rather been favourable to the field; for the thorough hand-hoeing of the bean crop every other ſpring has rendered it ſo clean, that in the preſent wet year, there is ſcarcely any weed grown through the wheat crop, although it was laid flat five weeks ago.

"I have ſtated theſe facts as plainly and as clearly as I could in order to be underſtood, and I leave to others to draw their deductions.

"This experiment by no means goes to prove that there may be no ſpots where a ſummer fallow may not come into an eligible courſe; but I think I may ſay, that it is not neceſſary for land of a quality like mine. To bring it into practice in the open common fields, I well know, that many circumſtances are to be conſidered; and among theſe, I ſhall be aſked where the farmer is, in ſuch a caſe, to keep his ſheep, as in farms of that nature he has ſo little paſture, and would be diſtreſſed was he to loſe the manure from the folding of theſe ſheep. This becomes a new queſtion, and deſerves conſideration. Much, I conceive, may be ſaid upon it; and, if I miſtake not, ſome means may be found to obviate the objection.

" I omitted mentioning one circumſtance, which may merit the attention of a farmer; it is this: Whether, after the given coat of muck every third year, the wheat crop, which preceded that of beans, had a claim to a preference to that which was ſown after the beans; and here I do not heſitate to give my opinion in favour of the latter. I apprehend, that the hoeing of the beans cleared the lands of ſuch weeds as might have been brought on with the muck, and ſtill left the ground in good heart for the wheat.

" I wiſh to add, that a neighbouring farmer has, on ſeeing the effect of this culture of mine, carried it into practice with a little alteration; for he has mucked his field every ſecond year in the winter, and ſowed it in ſpring, with the bean crop preceding that of wheat. Nor has he, any more than myſelf, had to complain that the bean crop, directly on the mucking, ran ſo much into height as to weaken the ſtem, and prevent its being properly kidded. Indeed this is the general notion of farmers in this part of the country; taken up, I believe, entirely from a groundleſs tradition, and not at all from proof.—P. S. The wheat was cut yeſterday, and the reapers tell me that it is fair in hand, lighter than laſt year's, but heavier than that of the ſeaſon before."

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Upon this intereſting ſubject of preparing land for wheat, the moſt important diſcovery undoubtedly is, the uſe of red clover for that purpoſe, upon a ſoil that is tolerably open. It binds the ſoil, and gives to it a degree of tenacity which is extremely ſuitable to wheat; at the ſame time, that the roots of the plant rotting in the earth afford a valuable manure: and in whatever way clover may act as a preparation for this grain experience leaves no doubt of its beneficial effects. The wheat ought to be ſown upon the firſt year's clover after a ſingle ploughing. To do it every juſtice, the clover ought to be only once mown. The after crop ought to be fed upon the land, which ought not to be overſtocked with cattle, that a conſiderable quantity of the green crop may be ploughed in. In the uſe of clover, however, ſome caution is neceſſary. Mr Young remarks *, that "all good farmers in England know, from long experience, that the common red clover is no friend to clean farming, if ſown with a ſecond or third crop of corn. In the courſe, 1ſt, Turnips or cabbages; 2d, Barley or oats; 3d, Clover; 4th, Wheat; the land is kept in garden order. But, if after that fourth crop the farmer goes on and ſows, 5th, Barley or oats; 6th, Clover; 7th, Wheat; the land will be both foul and exhauſted. In a word, clover is beneficial to the really good and clean farmer, only to the extent of his turnips, cabbages, and fallow; and never ought to be ſown but on land previouſly cleaned by thoſe hoeing crops

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* *Travels*, vol. ii.

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crops or fallow. As to fallow, no Frenchman ever makes it but for wheat; conſequently the culture of clover is excluded. I have often ſeen it ſown in this courſe· 1ſt, Fallow; 2d, Wheat; 3d, Barley; 4th, Oats; 5th, Clover; 6th, Clover; 7th, Wheat; 8th, Oats; and the land inevitably full of weeds. I may venture to aſſert, that clover thus introduced or even in courſes leſs reprehenſible, but not correct, will do more miſchief than good, and that a country is better cultivated without than with it. Hence, let the men, emulous of the character of good farmers, conſider it as eſſential to good huſbandry to have no more clover than they have turnips and cabbages, or ſome other crop that anſwers the ſame end, and never to ſow it but with the firſt crop of corn: By theſe means their land will be clean, and they will reap the benefits of the culture without the common evils.

"I have read in ſome authors an account of great German farmers, having ſuch immenſe quantities of clover as are ſufficient to prove the utter impoſſibility any preparation: theſe quantities are made a matter of boaſt. We know, however, in England, in what manner to appreciate ſuch extents of clover."

As a great part of our iſland conſiſts of a clayey ſoil, which is the leaſt of all ſuited to green or drilled crops, many ſkilful farmers are ſtill of opinion, that upon ſuch ſoils the uſe of ſummer fallow cannot with propriety be relinquiſhed; and, as others, from a love of old practices, are unwilling in any caſe to relinquiſh it, we ſhall here give a general account of the mode of practiſing it.

Fallowing for wheat.

Any time from the middle of April to the middle of May, the fallowing may commence. The moment ſhould be choſen, when the ground, beginning to dry, has yet ſome remaining ſoftneſs: in that condition, the ſoil divides eaſily by the plough, and falls into ſmall parts. This is an eſſential article, deſerving the ſtricteſt attention of the farmer. Ground ploughed too wet, riſes, as we ſay, *whole-fur*, as when paſture-ground is ploughed: where ploughed too dry, it riſes in great lumps, which are not reduced by ſubſequent ploughings; not to mention, that it requires double force to plough ground too dry, and that the plough is often broken to pieces. When the ground is in proper order, the farmer can have no excuſe for delaying a ſingle minute. This firſt courſe of fallow muſt, it is true, yield to the barley-ſeed; but as the barley-ſeed is commonly over the firſt week of May, or ſoóner, the ſeaſon muſt be unfavourable if the fallow cannot be reached by the middle of May.

As clay ſoil requires high ridges, theſe ought to be cleaved at the firſt ploughing, beginning at the furrow, and ending at the crown. This ploughing ought to be as deep as the ſoil will admit: and water-furrowing ought inſtantly to follow; for if rain happen before water-furrowing, it ſtagnates in the furrow, neceſſarily delays the ſecond ploughing till that part of the ridge be dry, and prevents the furrow from being mellowed and roaſted by the ſun. If this firſt ploughing be well executed, annual weeds will riſe in plenty.

About the firſt week of June, the great brake will looſen and reduce the ſoil, encourage a ſecond crop of annuals, and raiſe to the ſurface the roots of weeds moved by the plough. Give the weeds time to ſpring, which may be in two or three weeks. Then proceed to the ſecond ploughing about the beginning of July;

which muſt be croſs the ridges, in order to reach all the ſlips of the former ploughing. By croſs-ploughing the furrows will be filled up, and water-furrowing be ſtill more neceſſary than before. Employ the brake again about the 10th of Auguſt, to deſtroy the annuals that have ſprung ſince the laſt ſtirring. The deſtruction of weeds is a capital article in fallowing: yet ſo blind are people to their intereſt, that nothing is more common than a fallow field covered with charlock and wild muſtard, all in flower, and 10 or 12 inches high. The field having now received two harrowings and two brakings is prepared for manure, whether lime or dung, which without delay ought to be incorporated with the ſoil by a repeated harrowing and a gathering furrow. This ought to be about the beginning of September, and as ſoon after as you pleaſe the ſeed may be ſown.

As in ploughing a clay ſoil it is of importance to prevent poaching, the hinting furrows ought to be done with two horſes in a line. If four ploughs be employed in the ſame field, to one of them may be allotted the care of finiſhing the hinting furrows.

Dreſſing loam for wheat.

Loam, being a medium between ſand and clay, is of all ſoils the fitteſt for culture, and the leaſt ſubject to chances. It does not hold water like clay; and when wet, it dries ſooner. At the ſame time, it is more retentive than ſand of that degree of moiſture which promotes vegetation. On the other hand, it is more ſubject to couch-graſs than clay, and to other weeds; to deſtroy which, fallowing is ſtill more neceſſary than in clay.

Beginning the fallow of this kind of ſoil about the firſt of May, or as ſoon as barley ſeed is over, take as

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deep a furrow as the ſoil will admit. Where the ridges are ſo low and narrow as that the crown and furrow can be changed alternately, there is little or no occaſion for water-furrowing. Where the ridges are ſo high as to make it proper to cleave them, water-furrowing is proper. The ſecond ploughing may be at the diſtance of five weeks. Two crops of annuals may be got in the interim, the firſt by the brake and the next by the harrow; and by the ſame means eight crops may be got in the ſeaſon. The ground muſt be cleared of couch-graſs and knot-graſs roots, by the cleaning harrow deſcribed above. The time for this operation is immediately before the manure is laid on. The ground at that time being in its looſeſt ſtate, parts with its graſs roots more freely than at any other time. After the manure is ſpread, and incorporated with the ſoil by braking or harrowing, the ſeed may be ſown under furrow, if the ground hang ſo as eaſily to carry off the moiſture. To leave it rough without harrowing has two advantages: it is not apt to cake with moiſture, and the inequalities make a ſort of ſhelter to the young plants againſt froſt. But if it lie flat, it ought to be ſmoothed with a ſlight harrow after the ſeed is ſown, which will facilitate the courſe of the rain from the crown to the furrow.

Dreſſing a ſandy ſoil.

A ſandy ſoil is too looſe for wheat. The only chance for a crop is after red clover, the roots of which bind the ſoil. Rye is a crop much fitter for ſand ſoil than wheat; and like wheat, it is generally ſown after a ſummer fallow.

Time for ſowing.

Laſtly, Sow wheat as ſoon in the month of October as the ground is ready. When ſown a month more early, it is too forward in the ſpring, and apt to be hurt by froſt: when ſown a month later, it has not time to take root before froſt comes on; and froſt caſts it out of the ground.

Setting of wheat,

Setting of wheat, may be here noticed as being a method which by ſome is reckoned one of the greateſt improvements in huſbandry that took place during the late century. It ſeems to have been firſt ſuggeſted by planting grains in a garden from mere curioſity, by perſons who had no thought or opportunity of extending it to a lucrative purpoſe. Nor was it attempted on a larger ſcale, till a little farmer near Norwich began it upon leſs than an acre of land. For two or three years only a few followed his example; and theſe were generally the butt of their neighbours merriment for adopting ſo ſingular a practice. They had, however, conſiderably better corn and larger crops than their neighbours: this, together with the ſaving in ſeed, engaged more to follow them: while ſome ingenious perſons, obſerving its great advantage, recommended and publiſhed its utility in the Norwich papers. Theſe recommendations had their effect. The curioſity and inquiry of the Norfolk farmers (particularly round Norwich) were excited, and they found ſufficient reaſon to make general experiments. Among the reſt was one of the largeſt occupiers of land in that county, who ſet 57 acres in one year. His ſucceſs, from the viſible ſuperiority of his crop, both in quantity and quality, was ſo great, that the following autumn he ſet 300 acres, and has continued the practice ever ſince. This noble experiment eſtabliſhed the practice, and was the means of introducing it generally among the intelligent farmers in a very large diſtrict of land; there being few who now ſow any wheat, if they can procure hands

a capital improvement in agriculture.

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to ſet it. It has been generally obſerved, that although the ſet crops appear very thin during the autumn and winter, the plants ſide-ſhoot and ſpread prodigiouſly in the ſpring. The ears are indiſputably larger, without any dwarfiſh or ſmall corn; the grain is of a larger bulk, and ſpecifically heavier per buſhel than when ſown.

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The lands on which this method is particularly proſperous, are either after a clover ſtubble, or on which trefoil and graſs ſeeds were ſown the ſpring before the laſt. Theſe grounds, after the uſual manuring, are once turned over by the plough in an extended flag or turf, at ten inches wide; along which a man, who is called a *dibbler*, with two ſetting-irons, ſomewhat bigger than ramrods, but conſiderably bigger at the lower end, and pointed at the extremity, ſteps backwards along the turf, and makes the holes about four inches aſunder every way, and an inch deep. Into theſe holes the droppers (women, boys, and girls) drop two grains, which is quite ſufficient. After this, a gate buſhed with thorns is drawn by one horſe over the land, and cloſes up the holes. By this mode, three pecks of grain are ſufficient for an acre; and being immediately buried, the grain is equally removed from vermin or the power of froſt. The regularity of its riſing gives the beſt opportunity of keeping it clear from weeds, by weeding or hand-hoeing.

Method.

Wheat-ſetting is a method peculiarly beneficial when corn is dear; and, if the ſeaſon be favourable, may be practiſed with great benefit to the farmer. Sir Thomas Beevor of Hethel-Hall in Norfolk, found the produce to be two buſhels per acre more than from the wheat which is ſown; but having much leſs ſmall corn

Peculiar advantages.

intermixed with it, the ſample is better, and always fetches a higher price, to the amount generally of two ſhillings per quarter.

This method, too, ſaves to the farmer and to the public ſix pecks of ſeed wheat in every acre; which, if nationally adopted, would of itſelf afford bread for more than half a million of people.

Add to theſe conſiderations, the great ſupport given to the poor by this *ſecond* harveſt, as it may be called, which enables them to diſcharge their rents and maintain their families without having recourſe to the pariſh.—The expence of ſetting by hand is now reduced to about ſix ſhillings per acre; which, in good weather, may be done by one dibbler, attended by three droppers, in two days. This is five ſhillings per day; of which if the dibbler gives to the children ſixpence each, he will have himſelf three ſhillings and ſixpence for his day's work, which is much more than he can poſſibly earn by any other labour ſo eaſy to himſelf. But put the caſe, that the man has a wife who dibbles with him, and two or three of his own children to drop to him, you ſee his gains will then be prodigious, and enough to enſure a plenty of candidates for that work, even in the leaſt populous parts of the country.

It is, however, to be obſerved with regard to this method, that in ſeaſons when ſeed-corn is very cheap, or the autumn particularly unfavourable to the practice, it muſt certainly be leſſened. In light lands, for inſtance, a very dry ſeed time prevents dibbling; as the holes made with the inſtruments will be filled up again by the mould as faſt as the inſtrument is withdrawn. So, again, in a very wet ſeaſon, on ſtrong and ſtiff clays, the ſeeds in the holes cannot be well and properly co-

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vered by the buſhes drawn over them. But theſe extremes of dry and wet do not often happen, nor do they affect lands of a moderately conſiſtent texture, or both light and heavy ſoils at the ſame time; ſo that the general practice is in fact never greatly impeded by them.

Propagating of wheat by dividing the roots.

Propagating of wheat by dividing and tranſplanting its roots. In the Philoſophical Tranſactions for 1768, we meet with a very important experiment, of which the following is an abſtract. On the 2d of June 1766, Mr C. Miller ſowed ſome grains of the common red wheat; and on the 8th of Auguſt a ſingle plant was taken up and ſeparated into 18 parts, and each part planted ſeparately. Theſe plants having puſhed out ſeveral ſide-ſhoots, by about the middle of September; ſome of them were then taken up and divided, and the reſt of them between that time and the middle of October. This ſecond diviſion produced 67 plants. Theſe plants remained through the winter, and another diviſion of them, made between the middle of March and the 12th of April, produced 500 plants. They were then divided no further, but permitted to remain. The plants were in general ſtronger than any of the wheat in the fields. Some of them produced upwards of 100 ears from a ſingle root. Many of the ears meaſured ſeven inches in length, and contained between 60 and 70 grains.

The whole number of ears which, by the proceſs above mentioned, were produced from one grain of wheat, was 21,109, which yielded three pecks and three quarters of clean corn, the weight of which was 47lb. 7 ounces; and from a calculation made by counting the

number

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number of grains in an ounce, the whole number of grains was about 576,840.

By this account we find, that there was only one general diviſion of the plants made in the ſpring. Had a ſecond been made, Mr Miller thinks the number of plants would have amounted to 2000 inſtead of 500, and the produce thereby been much enlarged.

The ground was a light blackiſh ſoil, upon a gravelly bottom; and, conſequently, a bad ſoil for wheat. One half of the ground was well dunged, the other half had no manure. There was, however, not any difference diſcoverable in the vigour, or growth, or produce, of the plants.

Method propoſed by Mr Bogle

It muſt be evident, that the expence and labour of ſetting in the above manner by the hand, will render it ſcarcely practicable upon a large ſcale ſo as to be productive of any utility. A correſpondent of the Bath Society, therefore, (Robert Bogle, Eſq. of Daldowin, near Glaſgow, with a view to extend the practice, has propoſed the uſe of the harrow and roller until ſome better implements be invented. This method occurred to him from attending to the practice uſual with farmers on certain occaſions, of harrowing their fields after the grain is ſprung up. Upon inveſtigating the principles upon which theſe practices are founded, he found them confined merely to that of pulverizing the earth, without any attention to Mr Miller's doctrine. They ſaid, " that after very heavy rains, and then exceſſive dry weather, the ſurface of their lands was apt to be caked, the tender fibres of the young roots were thereby prevented from puſhing, and of courſe the vegetation was greatly obſtructed; in ſuch inſtances, they found very great benefit from harrowing and rolling."

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Theſe principles he acknowledges to be well founded, ſo far as relates to pulverizing; but contends, that the benefit ariſing from harrowing and rolling is not derived from pulverizing entirely, but alſo from ſubdividing and enabling the plants to tiller (as it is termed), or ſideſhoot. "The harrow (he obſerves) certainly breaks the incruſtation on the ſurface, and the roller crumbles the clods; but it is alſo obvious, that the harrow removes a great many of the plants from their original ſtations; and that if the corn has begun to tiller at the time it is uſed, the roots will be, in many inſtances, ſubdivided, and then the application of my ſyſtem of diviſibility comes into play. The roller then ſerves to plant the roots which have been torn up by the harrow."

Objections.

But on this the Society obſerve, that the teeth of a harrow are too large to divide roots ſo ſmall and tenacious as are thoſe of grain; and whenever ſuch roots (however tillered) ſtand in the line any tooth makes, they will, if ſmall, be only turned on one ſide by the earth yielding to their lateral preſſure, or, if large, the whole root will probably be drawn out of the ground. The principal uſes, therefore, derived from harrowing and rolling theſe crops are, opening the ſoil between the plants, earthing them up, breaking the clods, and cloſing the earth about their roots.

In a ſubſequent letter, Mr Bogle, without conteſting theſe points, further urges the ſcheme of propagating wheat by dividing and tranſplanting its roots. "I have converſed (ſays he) much with many practical farmers, who all admit that my plan has the appearance not only of being practical, but advantageous. I have

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alſo ſeen, in the ninth number of Mr Young's Annals of Agriculture, the account of an experiment which ſtrongly corroborates my theory. It was made by the Rev. Mr Pike of Edmonton. From this, and other experiments which have been made under my own eye, I foreſee clearly, that the ſyſtem is practicable, and will certainly be productive of great benefit, ſhould it become general. Beſides the ſaving of nine-tenths of ſeed in the land ſown broad-caſt, other very important advantages will attend the ſetting out of wheat from a ſeed-bed: ſuch as an early crop; the certainty of good crops; rendering a ſummer-fallow unneceſſary; ſaving dung; and having your wheat perfectly free from weeds, without either hand or horſe-hoeing. Five hundred plants in April produced almoſt a buſhel of grain. My gardener ſays, he can ſet one thouſand plants in a day, which is confirmed by the opinion of two other gardeners. Mr Miller found no difference in the produce of what was planted on lands that had dung, and on what had none, except where the land was improper for wheat at all."

Practicability of the ſcheme aſſerted.

Bath Society's obſervations.

On this letter we have the following note by the ſociety: "Mr Bogle will ſee, by the Society's premium book this year, that by having offered ſeveral premiums for experiments of the kind he ſo earneſtly recommends, we wiſh to have his theory brought to the teſt of practice. Our reaſon for this, as well as for printing Mr B's letter, was rather to excite deciſive trials by ingenious perſons, than from any expectation of the practice ever becoming a general one. General, indeed, it never can be. A ſufficient number of hands could not be found to do it. Unkindly ſeaſons at the time of tranſplanting and dividing the roots would frequently

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ntly endanger and injure, if not deſtroy, the crops. But admitting the mode generally practicable, we very much doubt whether all the advantages he has enumerated would be derived from this mode of culture. Why ſhould dividing and tranſplanting the roots of wheat cauſe the crop to be early, or afford a *certainty* of its being *a good one?* We cannot think that *leſs manure* is neceſſary in this method than either in drilling or broad-caſt; nor can we by any means admit, ſuch crops would ‘ be perfectly free from weeds without either hand or horſe-hoeing.’ We readily agree with Mr Bogle, that by this mode of culture on a general ſcale, an immenſe quantity of ſeed-corn would be annually ſaved to the nation; and in this, we believe, the advantage, were it practicable, would principally conſiſt.”

Further ol ſervations of Mr Bogle.

Upon the ſame ſubject, and that of harrowing all kinds of corn, we are informed, Mr Bogle afterwards communicated to the Society his thoughts more at large, together with authentic accounts which were made at his inſtance, and which were attended with very great ſucceſs. Theſe muſt undoubtedly be regarded as of very great importance, and accordingly the Society, conceiving his ſyſtem may be attended with conſiderable advantages if brought into general practice, have given, at the end of their third volume, a few of his leading principles. Mr Bogle ſtates, 1. That he has known many inſtances of very great crops having been obtained by harrowing fields of corn after they were ſprouted; and therefore recommends the practice very warmly.

2. That he has alſo received an authentic account of

one inſtance where the ſame good effects were produced by ploughing the field.

3. On the ſyſtem of tranſplanting, he ſtates, that a very great proportion of the ſeed will be ſaved, as a farmer may have a nurſery, or ſmall patch of plants, from which his fields may be ſupplied; he calculates that one acre will yield plants ſufficient for 100 acres.

4. That a very great increaſe of crops may be obtained by this method, probably a double crop, nay perhaps a triple quantity of what is reaped either by drilling or by the broad-caſt huſbandry.

5. That a great part of the labour may be performed by infirm men and women, and alſo by children, who are at preſent ſupported by the pariſh charity; and that of courſe the poor's rates may be conſiderably reduced.

6. That the expence will not exceed from 20s. to 30s. per acre, if the work be performed by able-bodied men and women; but that it will be much lower, if that proportion of the work which may be done by employing young boys and girls ſhould be allotted to them.

7. That in general he has found the diſtance of nine inches every way a very proper diſtance for ſetting out the plants at; but recommends them to be tried at other ſpaces, ſuch as 6, 8, or even 12 inches.

8. That he conceives an earlier crop may be obtained in this manner than can be obtained by any other mode of cultivation.

9. That a clean crop may alſo be procured in this way; becauſe if the land be ploughed immediately before the plants are ſet out, the corn will ſpring much quicker from the plants than the weeds will do from

ſeeds; and the corn will thereby bear down the growth of the weeds.

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10. That ſuch lands as are overflowed in the winter and ſpring, and are of courſe unfit for ſowing with wheat in the autumn, may be rendered fit for crops of wheat by planting them in the ſpring, or even in the ſummer.

11. That he has known inſtances of wheat being tranſplanted in September, October, November, February, March, April, and even as late as the middle of May, which have all anſwered very well.

12. That he has known an early kind of wheat ſown as late as the middle of May, which has ripened in very good time; and from that circumſtance he conceives, if the plants ſhould be taken from that early kind, the ſeaſon of tranſplanting might be prolonged at leaſt till the 1ſt of July, perhaps even later.

13. That he has reaſon to think wheat, oats, and barley, are not annuals, but are perennials, provided they are eaten down by cattle and ſheep, or are kept low by the ſcythe or ſickle; and are prevented from ſpindling or coming to the ear.

14. That one very prevalent motive with him in proſecuting this plan, is, that he is of opinion it may enable government to deviſe means of ſupporting the vagrant poor, both old and young, who are now to be met with everywhere, both in towns and in the country, and who are at preſent a burden on the community: but if ſuch employment could be ſtruck out for them, a comfortable ſubſiſtence might be provided for them by means of their own labour and induſtry; and not only ſave the public and private charitable contributions, but may alſo render that claſs of people uſeful and profitable

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able ſubjects; inſtead of their remaining in a uſeleſs, wretched, and perhaps a profligate and vicious courſe of life.

Laſtly, Mr Bogle has hinted at a ſecondary object which he has in view, from this mode of cultivation, which he apprehends may in time, with a ſmall degree of attention, prove extremely advantageous to agriculture.—It is, that, in the firſt place, the real and intrinſic value of different kinds of grain may be more accurately aſcertained, by making a compariſon of it with a few plants of each kind ſet out at the ſame time, than can be done when ſown in drills or broad-caſt; and when the moſt valuable kinds of wheat, oats, or barley, are diſcovered, he ſtates, that in a very ſhort time (not exceeding four or five years) a ſufficient quantity of that valuable kind may be procured to ſupply the kingdom with ſeed from a ſingle grain of each kind; for he calculates, that 47,000 grains of wheat may be produced by diviſibility in two years and three months.

Obſervation of the Bath Society.

Upon theſe propoſitions the Society obſerves, "That although Mr Bogle appears to be too ſanguine in his expectations of ſeeing his plan realized in *general practice*, it certainly merits the attention of gentlemen farmers. We wiſh them to make fair experiments, and report their ſucceſs. All grand improvements have been, and ever will be, progreſſive. They muſt neceſſarily originate with gentlemen; and thence the circle is extended by almoſt imperceptible degrees over provinces and countries. At all events, Mr Bogle is juſtly entitled to the thanks of the Society, and of the public, for the great attention he has paid to the ſubject."

There is perhaps no part of Great Britain where wheat

Culture of wheat in Norfolk.

wheat is cultivated to more perfection than in Norfolk. Mr Marſhal informs us, that the ſpecies raiſed in that county is called the *Norfolk red*, and weighs heavier than any other which has yet been introduced, though he owns that its appearance is much againſt the aſſertion, it being a long thin grain, reſembling rye more than well-bodied wheat. About 15 or 20 years ago a new ſpecies was introduced, named the *Kentiſh coſh*; againſt which the millers were at firſt very much prejudiced, though this prejudice is now got over. A remarkable circumſtance reſpecting this grain is, that though upon its introduction into the county the *coſh* or huſk be perfectly white, yet ſuch is the power either of the ſoil or of the mode of cultivation to produce what the botaniſts call *varieties*, that the grain in queſtion is ſaid to loſe every year ſomewhat of the whiteneſs of its huſks, until they become at laſt equally red with thoſe of the former kind. The ſouthern and ſouth-eaſtern parts of the county generally enjoy a ſtronger and richer ſoil than the more northerly, and therefore are more proper for the cultivation of that ſpecies of grain. In the northern parts are ſome farms of very light ſoil, where the farmers ſow only a ſmall quantity of wheat; and theſe light lands are called *barley farms*.

Succeſſion of crops.

The greateſt part of the wheat in Norfolk is ſown upon a ſecond year's ley: ſometimes it is ſown upon a firſt year's ley; ſometimes on a ſummer fallow; after peas, turnips, or buck harveſted or ploughed under. The practice adopted by thoſe who are looked upon as ſuperior huſbandmen in the county of Norfolk is as follows: The ſecond year's leys having finiſhed the bullocks, and brought the flock cattle and horſes through

Rice-balking, a particular mode of culture explained.

through the fore part of ſummer, and the firſt years leys having been made ready to receive his ſtock, the farmer begins to break up his old land or ley ground by a peculiar mode of cultivation named *rice-balking*, in which the furrow is always turned toward the unploughed ground, the edge of the coulter paſſing always cloſe by the edge of the flag laſt turned. This is done at firſt with an even regular furrow; opportunity being taken for performing the operation after the ſurface has been moiſtened by a ſummer ſhower. In this ſtate his ſummer leys remain until towards the end of harveſt, when he harrows and afterwards ploughs them acroſs the balks of the former ploughing, bringing them now up to the full depth of the ſoil. On this ploughing he immediately harrows the manure, and ploughs it in with a ſhallow furrow. The effects of this third ploughing are to mix and effectually pulverize the ſoil and manure; to cut off and pulverize the upper ſurfaces of the furrows of the ſecond ploughing; and thus, in the moſt effectual manner, to eradicate or ſmother the weeds which had eſcaped the two former ones. Thus it lies until the ſeed time, when it is harrowed, rolled, ſown, and gathered up into ridges of ſuch width as the farmer thinks moſt proper. Thoſe of ſix furrows are moſt common, though ſome very good farmers lay their wheat land into four-furrow, and others into ten-furrow ridges; "which laſt (ſays our author) they execute in a ſtyle much ſuperior to what might be expected from wheel-ploughs." They excel, however, in the ſix-furrow ploughing; of which Mr Marſhal gives a particular account. When ploughing in this manner, they carry very narrow furrows; ſo that a ſix-furrow ridge, ſet out by letting the off-horſe return in the firſt-made furrow, does not meaſure more than three feet eight or nine inches.

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When wheat is cultivated after the firſt year's ley, the ſeed is generally ſown upon the flag or furrow turned over. After peaſe, one or two ploughings are given; the other parts of the management being the ſame with that after the ſecond year's ley already mentioned. After buck harveſted he ſeldom gives more than two, and ſometimes but one, ploughing. In the former caſe he ſpreads his manure on the ſtubble, and ploughs it in with a ſhallow furrow; harrows, rolls, ſows, and gathers up the ſoil into narrow work. The manure is in like manner ſpread on the ſtubble after once ploughing, and the ſeed is then ſown among the manure; the whole ploughed in together, and the ſoil gathered up into narrow ridges, as if it had undergone the operations of a fallow. An inconvenience attending this practice is, that the buck which is neceſſarily ſhed in harveſting ſprings up among the wheat, and becomes a weed to it, at the ſame time that the rooks, if numerous, pull up both buck and wheat, leaving ſeveral patches quite bare. This is obviated in a great meaſure by firſt ploughing in the manure and ſelf-ſown buck with a ſhallow furrow, in conſequence of which the buck vegetates before the wheat.

It is likewiſe a favourite practice with the Norfolk farmers to raiſe wheat after buck ploughed under. They plough under the buck by means of a broom made of rough buſhes fixed to the fore tackle of the plough between the wheels, which bears down the plant without lifting the wheels from the ground. Sometimes, when the buck is ſtrong, they firſt break it down with a roller going the ſame way that the plough is intended.

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ed to go; afterwards a good ploughman will cover ſo effectually that ſcarce a ſtalk can be ſeen. Sometimes the ſurface of the ground is left rough, but it is more eligible to harrow and roll it. The practice of ſummer-fallowing ſeldom occurs in Norfolk; though ſometimes, when the ſoil has been much worn down by cropping, and overrun by weeds, it is eſteemed a judicious practice by many excellent huſbandmen, and the practice ſeems to be daily gaining ground. After turnips the ſoil is ploughed to a moderate depth, and the ſeed ſown over the firſt ploughing: but if the turnips be got in early, the weeds are ſometimes firſt ploughed in with a ſhallow furrow, and the ſeed ploughed under with a ſecond ploughing, gathering the ſoil into narrow ridges.

Manuring the ground in Norfolk

With regard to the manuring of the ground for wheat in Norfolk, that which has been recently clayed or marled is ſuppoſed to need no other preparation any more than that which has received 15 or 20 loads of dung and mould for turnips; the firſt year's ley having been teathed in autumn, and the ſecond fed off. Where the ſoil is good, and the wheat apt to run too much to ſtraw, it is the practice of ſome judicious farmers to ſet their manure upon the young clover, thereby depriving the wheat in ſome degree of its rankneſs; but it is moſt common to ſpread it upon the broken ground; or, if the ſeed be ſown upon the turned furrow, to ſpread it on the turf and plough it under; or to ſpread it on the ploughed ſurface, and harrow it in with the ſeed as a top-dreſſing. A ſmaller quantity of manure is generally made uſe of for wheat than for turnips. From eight to ten cart loads (as much as three horſes can conveniently draw) are reckoned

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reckoned ſufficient for an acre; three or four chaldrons of lime to one acre, or 40 buſhels of ſoot to the ſame quantity of ground; or about a ton of rape-cake to three acres.

Time of ſowing.

In this county they never begin to ſow wheat till after the 17th of October, and continue till the beginning of December, ſometimes even till Chriſtmas. They give as a reaſon for this late ſowing, that the wheat treated in this manner is leſs apt to run to ſtraw than when ſown earlier. The ſeed is generally prepared with brine, and candied in the uſual manner with lime. The following method of preparing it is ſaid to be effectual in preventing the ſmut. "The ſalt is diſſolved in a very ſmall quantity of water, barely ſufficient for the purpoſe. The lime is ſlaked with this ſolution, and the wheat candied with it in its hotteſt ſtate, having been previouſly moiſtened with pure water." According to our author's obſervation, the crops of thoſe farmers who uſe this preparation are in general more free from ſmut than thoſe who make uſe of any other.

Of preparing the ſeed.

Method of ſowing.

The practice of dibbling or ſetting of wheat has not as yet become general throughout Norfolk, the common broad-caſt method being uſually followed, except on the Suffolk ſide of the county. Some few make uſe of dibbling and fluting rollers; but drilling is almoſt entirely unknown, notwithſtanding the great aptitude of ſoil for the practice. Ploughing in the ſeed under furrow is the favourite mode of the Norfolk farmers, and is performed in the following manner: "The land having been harrowed down level, and the ſurface rendered ſmooth by the roller, the head ploughman (if at leiſure) marks out the whole piece in narrow ſlips of about a ſtatute

Ploughing the ſeed in deſcribed.

ſtatute rood in width. This he does by hanging up a plough in ſuch a manner, that no part of it except the heel touches the ground; and this makes a ſure mark for the ſeedſman, which he cannot by any means miſtake. In caſe the ploughs are all employed, the ſeedſman himſelf marks the ground, by drawing a piece of wood or other heavy body behind him. Mr Marſhal prefers this to the Kentiſh method of ſetting up ſticks in the form of a lane, as being leſs liable to produce miſtakes.

Inſtruments for dibbling wheat deſcribed.

In thoſe places where wheat is dibbled, they make uſe of iron inſtruments for the purpoſe. The acting part is an egg-ſhaped knob, ſomewhat larger than a pigeon's egg; the ſmaller end is the point of the dibble, the larger having a rod of iron riſing from it about half an inch ſquare, and two feet and a half long; the head being received into a croſs piece of wood reſembling the crutch of a ſpade or ſhovel, which forms the handle The dibbler uſes two of theſe inſtruments, one in each hand; and, bending over them, walks backward upon the turned furrows, making two rows of holes in each of them. Thoſe rows are uſually made at the diſtance of four inches from each other; the holes being two and a half or three inches diſtant, viz. four in each length of the foot of the dibbler. The great art in making theſe lies in leaving them firm and ſmooth in the ſides, ſo that the looſe mould may not run in to fill them up before the ſeeds are depoſited. This is done by a circular motion of the hand and wriſt; making a ſemi-revolution every ſtroke; the circular motion beginning as the bit enters, and continuing until it is entirely diſengaged from the mould. The operation is not perfect unleſs the dibbles come out clean and wear bright.

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eight. It is ſomewhat difficult to make the holes at equal diſtances; but more eſpecially to keep the two ſtraight and parallel to each other, ſome practice being required to guide the inſtruments in ſuch a manner as to correſpond exactly with each other; but though couples have been invented to remedy this inconvenience to keep them at a proper diſtance, the other method is ſtill found to be preferable. A middling workman will make four holes in a ſecond. One dibbler is ſufficient for three droppers; whence a man and three children are called a *ſet*. The dibbler carries on three flags or turned furrows; going on ſome yards upon one of the outſide furrows, and returning upon the other, after which he takes the middle one; and thus keeps his three dibblers conſtantly employed, and at the ſame time is in no danger of filling up the holes with his feet. The droppers put in two or three grains of wheat into each hole; but much time and patience is neceſſary to teach them to perform the buſineſs properly and quickly. An expert dibbler will hole half an acre in a day; though one third of an acre is uſually reckoned a good day's work. The ſeed is covered by means of a buſh harrow; and from one buſhel to ſix pecks is the uſual quantity for an acre. Notwithſtanding the advantages of ſaving ſeed, as well as ſome others which are generally reckoned undeniable, it is here aſſerted by ſome very judicious farmers, that dibbling of wheat on the whole is not really a profitable practice. It is particularly ſaid to be productive of weeds unleſs dibbled very thick: which indeed may probably be the caſe, as the weeds are thus allowed a greater ſpace to vegetate in. Mr Marſhal himſelf is of opinion, that "the dibbling of wheat ap-

Objections againſt the practice of dibbling.

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pears to be peculiarly adapted to rich deep ſoils, which three or four pecks dibbled early may ſpread ſufficiently for a full crop; whereas light, weak, ſhallow ſoils, which have lain two or three years, and have become graſſy, require an additional quantity of ſeed, and conſequently an addition of labour, otherwiſe the plants are not able to reach each other, and the graſſes of courſe find their way up between them, by which means the crop is injured and the ſoil rendered foul."

Culture of wheat in the midland diſtrict.

The ſame author has likewiſe given an account of the method of cultivating wheat practiſed in other Engliſh counties. In the midland diſtrict, including part of Staffordſhire, Derbyſhire, Warwick, and Leiceſterſhire, we are informed that the ſpecies uſually ſown is that called *Red Lammas*, the ordinary red wheat of the kingdom: but of late a ſpecies named the *Eſſex dun*, ſimilar to the *Kentiſh white coſh* of Norfolk, and the *Hertfordſhire brown* of Yorkſhire, has been coming into vogue. Cone-wheat, formerly in uſe in this diſtrict, is now out of faſhion. Spring wheat is cultivated with remarkable ſucceſs, owing principally to the time of ſowing; viz. the cloſe of April. Our author was informed by an excellent farmer in theſe parts, that by ſowing early, as in the beginning of March, the grain was liable to be ſhrivelled, and the ſtraw to be blighted; while that which was ſown towards the end of April, or even in the beginning of May, produced clean plump corn. At the time he viſited this county, however, it ſeemed to be falling into diſrepute; though he looks upon it, in ſome ſituations, eſpecially in a turnip country, to be eligible. In the ordinary ſucceſſion in this part of the kingdom, wheat

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comes after oats; and there is perhaps nine-tenths of the wheat in this diſtrict ſown upon oat-ſtubble. Our author has alſo ſeen a few examples of wheat being ſown upon turf of ſix or ſeven years leying; and ſeveral others on clover ley once ploughed, as well as ſome after turnips. The beſt crops, however, produced in this, or, as he thinks, in any other diſtrict, are after ſummer fallow. The time of ſowing is the month of October, little being ſown before Michaelmas; and in a favourable ſeaſon, little after the cloſe of the month. Much ſeed is ſown here without preparation. When any is made uſe of, it is the common one of brine candied with lime. The produce is very great, the medium being full three quarters per acre, ſometimes four or five; and one farmer, in the year 1784, had on 50 acres of land together, no leſs than 45 buſhels per acre.

In the Vale of Glouceſter.

In the Vale of Glouceſter, the *cone-wheat*, a variety of the *triticum turgidum*, is cultivated, as well as the lammas and ſpring wheats. It is not, however, the true cone wheat which is cultivated here, the ears being nearly cylindrical; but our author met with the true ſpecies in North Wiltſhire. Beans in this country are the common predeceſſors of wheat, and ſometimes peaſe; but here the farmers cultivate wheat upon every ſpecies of ſoil. The time of ſowing is in November and December, and the ſeed is thought to be ſown in ſufficient time if it is done before Chriſtmas. In this country it is thought that late ſown crops always produce better than thoſe which are ſown early; but Mr Marſhal accounts for this by the vaſt quantity of weeds the latter have to encounter, and which the late ſown crops eſcape by reaſon of the weakneſs of vegetation at that time of the year. The produce, however, throughout the Vale of Glouceſter, is but very indifferent.—Setting of wheat is not practiſed, but hoeing univerſally.—In harveſting, Mr Marſhal obſerves, that the grain is allowed to ſtand until it be unreaſonably ripe, and that it is bound up into very ſmall ſheaves. The practice of making double bands is unknown in this diſtrict; ſo that the ſheaves are no bigger than can be contained in the length of ſingle ſtraw. The inconveniences of this method are, that the crop requires more time to ſtook, load and unload, and ſtack: the advantages are, that the trouble of making bands is avoided; and that if rainy weather happens to intervene, the ſmall ſheaves dry much ſooner than the large ones. Here the crop is cut very high, the ſtubble and weeds being mown off in ſwaths for litter ſoon after the crop is cut; and ſometimes ſold as high as 5s. per acre.—Mr Marſhal is at a loſs to account for the little quantity produced in this country: it being hardly poſſible to derive it from the nature of the ſoil, almoſt all of it being proper for the cultivation of the grain.

Remarkably ſmall ſheaves.

In the Cotſwold hills.

Among the Cotſwold hills of Glouceſter the lammas and cone wheats are ſown; and a new variety of the latter was raiſed not long ago by picking out a ſingle grain of ſeed from among a parcel. The body is very long and large, but not ſightly.—The Cotſwold hills are almoſt proverbial for early ſowing of wheat. The general rule is to begin ploughing in July, and ſowing the firſt wet weather in Auguſt; ſo that here the ſeed-time and harveſt of wheat coincide. If, in conſequence of this early ſowing the blade becomes rank in autumn, it is ſuppoſed to be proper to eat it down by putting a large flock of ſheep upon it at once. Eating it in ſpring is

Inſtance of the good effects of hoeing wheat.

Of cutting mildewed wheat very green.

is conſidered as pernicious. It is uſually weeded with ſpud-hooks; not hoed, as in the Vale. One inſtance, however, is mentioned by our author, in which a very thin crop full of ſeed-weeds hoed in autumn with uncommon ſucceſs, occurred in the practice of a ſuperior manager in this diſtrict; as well as others in which wheat has been weeded in autumn with great advantage. He alſo here met with a well authenticated inſtance of the good effect of cutting mildewed wheat while very green. "A fine piece of wheat being lodged by heavy rains, and being ſoon after perceived to be infected with the mildew, was cut, though ſtill in a perfectly green ſtate; namely, about three weeks before the uſual time of cutting. It lay ſpread abroad upon the ſtubble until it became dry enough to prevent its caking in the ſheaf; when it was bound and ſet up in ſhocks. The reſult of this treatment was, that the grain, though ſmall, was of a fine colour, and the heavieſt wheat which grew upon the ſame farm that ſeaſon; owing, no doubt, to the thinneſs of its ſkin. What appears much more remarkable, the ſtraw was perfectly bright, not a ſpeck upon it.—In this part of the country, the produce of wheat is ſuperior to that in the Vale; but Mr Marſhal is of opinion, that the ſoil is much more fit for barley than wheat.

Cultivation of wheat in Yorkſhire.

In Yorkſhire, though generally a graſs land country, and where of conſequence corn is only a ſecondary concern, yet ſeveral kinds of wheat are cultivated, particularly *Zealand*, *Downy*, *Kent*, *Common White*, *Hertfordſhire Brown*, *Yellow Kent*, *Common Red*. All theſe are varieties of winter wheat; beſides which they cultivate alſo the *ſpring* or *ſummer wheat*. Here our author makes ſeveral curious obſervations concerning the raiſing of *va-*

Obſervations on raiſing varieties of plants.

rieties of plants. "It is probable, ſays he, that time has the ſame effect upon the varieties of wheat and other grains as it has on thoſe of cultivated fruits, potatoes, and other vegetable productions. Thus to produce an early pea, the gardener marks the plants which open firſt into bloſſom among the moſt early kind he has in cultivation. Next year he ſows the produce of thoſe plants, and goes over the coming crop in the manner he had done the preceding year, marking the earlier of this early kind. In a ſimilar manner new varieties of apples are raiſed, by chooſing the broadeſt leaved plants among a bed of ſeedlings riſing promiſcuouſly from pippins. Huſbandmen, it is probable, have heretofore been equally induſtrious in producing freſh varieties of corn; or whence the endleſs variety of winter wheats? If they be naturally of one ſpecies, as Linnæus has deemed them, they muſt have been produced by climate, ſoil, or induſtry; for although nature ſports with individuals, the induſtry of man is requiſite to raiſe, eſtabliſh, and continue a permanent variety. The only inſtance in which I have had an opportunity of tracing the *variety* down to the *parent individual*, has occurred to me in this diſtrict. A man of acute obſervation, having, in a piece of wheat, perceived a plant of uncommon ſtrength and luxuriance, diffuſing its branches on every ſide, and ſetting its cloſely-ſurrounding neighbours at defiance; marked it; and at harveſt removed it ſeparately. The produce was 15 ears, yielding 604 grains of a ſtrong-bodied liver-coloured wheat, different, in general appearance, from every other variety he had ſeen. The chaff was ſmooth, without awns, and of the colour of the grain; the ſtraw ſtout and reedy. Theſe 604 grains were planted ſingly, nine inches aſunder,

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der, filling about 40 ſquare yards of ground, on a clover ſtubble, the remainder of the ground being ſown with wheat in the ordinary way; by which means extraordinary trouble and deſtruction by birds were avoided. The produce was two gallons and a half, weighing 20⅕lb. of prime grain for feed, beſides ſome pounds of ſeconds. One grain produced 35 ears, yielding 1235 grains; ſo that the ſecond year's produce was ſufficient to plant an acre of ground. What deters farmers from improvements of this nature is probably the miſchievouſneſs of birds: from which at harveſt it is ſcarcely poſſible to preſerve a ſmall patch of corn, eſpecially in a garden or other ground ſituated near a habitation; but by carrying on the improvement in a field of corn of the ſame nature, that inconvenience is got rid of. In this ſituation, however, the botaniſt will be apprehenſive of danger from the floral farina of the ſurrounding crop. But from what obſervations I have made, I am of opinion his fears will be groundleſs. No evil of this kind occurred, though the cultivation of the above variety was carried on among *white* wheat. But this need not be brought as an evidence: it is not uncommon here to ſow a mixture of red and white wheats together; and this, it is confidently aſſerted, without impairing even the colour of either of them. The ſame mode of culture is applicable to the improvement of varieties, which perhaps would be more profitable to the huſbandman than raiſing new ones, and more expeditious."

Preparation of wheat with arſenic.

In Yorkſhire the very ſingular preparation of ſeed wheat prevails which we formerly mentioned, viz. the ſteeping it in a ſolution of *arſenic*, as a preventive of ſmut. Marſhal was informed by one farmer, that he

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had made uſe of this preparation for 20 years with ſucceſs, having never during that long ſpace of time ſuffered any ſenſible injury from ſmut. Our author ſeems inclined to believe the efficacy of this preparation; but thinks there may be ſome reaſon to apprehend danger in the uſe of ſuch a pernicious mineral, either through the careleſſneſs of ſervants, or handling of the ſeed by the perſon who ſows it. The farmer above mentioned, however, during all the time he uſed it, never experienced any inconvenience either to himſelf, the ſeedſman, or even to the poultry; though theſe laſt, we ſhould have thought, would have been peculiarly liable to accidents from arſenicated ſeed. The preparation is made by pounding the arſenic extremely fine, boiling it in water, and drenching the ſeed with the decoction. "In ſtrictneſs, ſays Mr Marſhal, the arſenic ſhould be levigated ſufficiently fine, to be taken up and waſhed over with water, reducing the ſediment until it be fine enough to be carried over in the ſame manner. The uſual method of preparing the liquor is to boil one ounce of white arſenic, finely powdered, in a gallon of water, from one to two hours; and to add to the decoction as much water or ſtale urine as will increaſe the liquor to two gallons. In this liquor the ſeed is, or ought to be, immerged, ſtirring it about in ſuch a manner as to ſaturate effectually the downy end of each grain. This done, and the liquor drawn off, the ſeed is conſidered as fit for the ſeed baſket, without being candied with lime, or any other preparation. A buſhel of wheat has been obſerved to take up about a gallon of liquor. The price of arſenic is about 6d. per pound; which, on this calculation, will cure four quarters of ſeed. If no more than three quarters be

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be prepared with it, the coſt will be only a farthing per buſhel; but to this muſt be added the labour of pounding and boiling. Nevertheleſs, it is by much the cheapeſt, and perhaps, upon the whole, adds Mr Marſhal, the beſt preparation we are at preſent acquainted with. In this county it is believed, that a mixture of wheat and rye, formerly a very common crop in theſe parts, is never affected with mildew; but our author does not vouch for the truth of this aſſertion.

Wheat and turnips ſown together.

We muſt not here omit to take notice of a new mode of cultivating wheat contrived by Mr E. Walker of Harply, Norfolk; which mode of culture we ſhall alſo afterwards have occaſion to notice when we come to treat of the culture of turnips. Mr Walker thus explains his mode of procedure in a letter addreſſed to the publiſher of the Annals of Agriculture *. "I ſow in broad-caſt, after the turnips have been once hoed, two buſhels of wheat or two buſhels of rye per acre; and then hoe the ſame in with the ſecond hoeing: if it be hoed by the day it may be beſt, as it will be better done by the ſhort ſtrokes or cuts with the hoes than otherwiſe. It is recommended to be done ſoon after the firſt hoeing, for many reaſons: It becomes a fine herbage, and keeps the land very clean, without any injury to the turnips, or to the wheat or rye. I began to feed in laſt September, the turnips, &c. the firſt of the month, and ſhall continue till all are done. I have fed off with all ſorts of ſtock mixed, and have drawn out the turnips in lines to ſet the hurdles, as is uſual, and fed off the turnips

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turnips and growing corn in wet and dry weather; but find that dry weather, and ſheep, is the propereſt time and ſtock; and that ſheep and light beaſts are the beſt for light lands, which, on the whole, this method will greatly improve.

"All my experiments have been made without mucking, or any manure; for the turnip and wheat crop; and on thoſe parts where I have fed off at the time it has been dry weather, though with all ſorts of ſtock mixed and drawing as above, I have grown at the rate of five coomb of wheat per acre, and at the rate of eight coomb of rye per acre; and ſome was almoſt totally deſtroyed by feeding off in wet weather, as I was determined not to deſiſt, that I might know the bad or good effects from feeding off the turnips with the corn in different weather, as well as the different months; all which I ſhall be able to give information of next year, to thoſe who wiſh to know. I find the feed nearly worth the coſt of the ſeed corn, which is a material conſideration in caſe you plough the land for barley or other ſummer corn; but if the wheat or rye ſtands a crop to your mind, it will do better to harrow it in the ſpring, at which time you may ſow your graſs ſeeds, which I find anſwer very well; or plough the ſtubble early in the autumn, and ſow with clover or other ſeeds."

The well-known author of the Annals of Agriculture has given a farther account of this method of cultivation. The idea which led to Mr Walker's experiments was this: Wheat requires a certain degree of ſtiffneſs and compactneſs in the ſoil upon which it is reared. Of this compactneſs, ſandy ſoils are apt to be deficient in proportion to the degree of tillage they receive.

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ceive. Hence it occurred to Mr Walker, that if wheat could be ſown without any ploughing at all, there would be a better chance of a crop upon certain ſoils, than after the moſt expenſive ſyſtem of tillage. Accordingly, in 1784, he executed his ſcheme on ſix acres of turnips, which were fed during the ſucceeding winter by bullocks and ſheep, like the reſt of his turnip fields, without making the leaſt diſtinction on account of the wheat that had been ſown and was growing among them. It is known, that turnip land, when fed off, is left highly manured and much trodden; and the queſtion was, whether the firſt of theſe circumſtances would not counterbalance the laſt? and, whether even the treading itſelf might not prove advantageous? The ſucceſs juſtified the project, and, in 1785, Mr Walker extended it to 35 acres, a part of which was ſown with rye. The management was the ſame as before; the wheat did better than the rye, and the beſt crop was where the turnips were eaten in the drieſt weather. In 1786, the ſame culture was extended to 70, and in 1797, to 100 acres, with complete ſucceſs; but the crop was not better than that raiſed in the common way, though in general as good. The effect of this mode of culture, or the profit ariſing from it, conſiſted chiefly in this, that upon a farm of 600 acres, the labour of five horſes was ſaved, and at the time of the barley-ſowing, when all his neighbours were in the greateſt hurry, he was at his eaſe quietly ſtirring his turnip fallows. The chief difficulty attending this mode of cultivating wheat aroſe from the wetneſs of the ſeaſon at the time of feeding, as the ground was apt to be too much trodden and poached, particularly when the crop of turnips was very large ſo as to keep the cattle long upon them. On the contrary, in dry or froſty weather nothing of this kind happened. The greater the crop of turnips, and the more treading that occurred, the crop of wheat ſeemed afterwards to proſper the better. In a wet ſeaſon, however, the evil ariſing from the treading was diminiſhed when ſheep alone without bullocks were introduced to conſume the turnips. Under this huſbandry, the following rotation was uſed: Two years graſs put in among the wheat-ſtubble, ploughed once, and harrowed both in autumn and ſpring with the whole dung of the farm; Third year, oats; Fourth turnips; Fifth, wheat.

2. OATS.

Effect of froſt upon tilled land.

As winter-ploughing enters into the culture of oats, we muſt remind the reader of the effect of froſt upon tilled land. Providence has neglected no region intended for the habitation of man. If in warm climates the ſoil be meliorated by the ſun, it is no leſs meliorated by froſt in cold climates. Froſt acts upon water, by expanding it into a larger ſpace. Froſt has no effect upon dry earth; witneſs ſand, upon which it makes no impreſſion. But upon wet earth it acts moſt vigorouſly; it expands the moiſture, which requiring more ſpace puts every particle of the earth out of its place, and ſeparates them from each other. In that view, froſt may be conſidered as a plough ſuperior to any that is made, or can be made, by the hand of man: its action reaches the minuteſt particles; and, by dividing and ſeparating them, it renders the ſoil looſe and friable. This operation is the moſt remarkable in tilled land, which gives free acceſs to froſt. With reſpect to clay ſoil in particular, there is no rule in huſbandry more eſſential than to open it before winter in hopes of froſt. It is even adviſable in a clay ſoil to leave the ſtubble rank; which, when ploughed in before winter, keeps the clay looſe, and admits the froſt into every cranny.

To apply this doctrine, it is dangerous to plough clay ſoil when wet; becauſe water is a cement for clay, and binds it ſo as to render it unfit for vegetation. It is, however, leſs dangerous to plough wet clay before winter than after. A ſucceeding froſt corrects the bad effects of ſuch ploughing; a ſucceeding drought increaſes them.

Culture of oats.

The common method is, to ſow oats on new-ploughed land in the month of March, as ſoon as the ground is tolerably dry. If it continues wet all the month of March, it is too late to venture them after. It is much better to ſummer-fallow, and to ſow wheat in the autumn. But the preferable method, eſpecially in clay ſoil, is to turn over the field after harveſt, and to lay it open to the influences of froſt and air, which leſſen the tenacity of clay, and reduce it to a free mould. The ſurface-ſoil by this means is finely mellowed for the reception of the ſeed; and it would be a pity to bury it by a ſecond ploughing before ſowing. In general, the bulk of clay ſoils are rich; and ſkilful ploughing without dung, will probably give a better crop, than unſkilful ploughing with dung.

Hitherto of natural clays. We muſt add a word of carſe clays which are artificial, whether left by the ſea, or ſweeped down from higher grounds by rain. The method commonly uſed of dreſſing carſe clay for oats, is, not to ſtir it till the ground be dry in the ſpring, which ſeldom happens before the 1ſt of March, and the ſeed is ſown as ſoon after as the ground is ſufficiently dry for its reception. Froſt has a ſtronger effect on ſuch clays than on natural clay. And if the field be laid open before winter, it is rendered ſo looſe by froſt as to be ſoon drenched in water. The particles at the ſame time are ſo ſmall, as that the firſt drought in ſpring makes the ſurface cake or cruſt. The difficulty of reducing this cruſt into mould for covering the oat-ſeed, has led farmers to delay ploughing till the month of March. But we are taught by experience, that this ſoil ploughed before winter, is ſooner dry than when the ploughing is delayed till ſpring; and as early ſowing is a great advantage, the objection of the ſuperficial cruſting is eaſily removed by the firſt harrow above deſcribed, which will produce abundance of mould for covering the ſeed. The ploughing before winter not only procures early ſowing, but has another advantage: the ſurface-ſoil that had been mellowed during winter by the ſun, froſt, and wind, is kept above.

The dreſſing a loamy ſoil for oats differs little from dreſſing a clay ſoil, except in the following particular, that, being leſs hurt by rain, it requires not high ridges, and therefore ought to be ploughed crown and furrow alternately.

Where there is both clay and loam in a farm, it is obvious, from what is ſaid above, that the ploughing of the clay after harveſt ought firſt to be deſpatched. If both cannot be overtaken that ſeaſon, the loam may be delayed till the ſpring with leſs hurt.

Next of a gravelly ſoil; which is the reverſe of clay, as it never ſuffers but from want of moiſture. Such a ſoil ought to have no ridges; but to be ploughed circularly from the centre to the circumference, or from the circumference to the centre. It ought to be tilled after harveſt: and the firſt dry weather in ſpring ought to be laid hold of to ſow, harrow, and roll; which will preſerve it in ſap.

The culture of oats is the ſimpleſt of all. That grain is probably a native of Britain: it will grow on the worſt ſoil with very little preparation. For that reaſon, as already noticed, before turnip was introduced, it was always the firſt crop upon land broken up from the ſtate of nature.

Upon ſuch land, may it not be a good method, to build upon the crown of every ridge, in the form of a wall, all the ſurface-earth, one ſod above another, as in a fold for ſheep? After ſtanding in this form all the ſummer and winter, let the walls be thrown down, and the ground prepared for oats. This will ſecure one or two good crops; after which the land may be dunged for a crop of barley and graſs-ſeeds. This method may anſwer in a farm where manure is ſcarce.

Norfolk cultivation of oats.

In Norfolk this kind of grain is much leſs cultivated than barley; and the only ſpecies obſerved by Mr Marſhal is a kind of white oat, which grows quickly, and ſeems to be of Dutch extraction. Oats are cultivated occaſionally on all kinds of ſoils, but more eſpecially on cold heavy land, or on very light, unproductive, heathy ſoils. They moſt frequently ſucceed wheat, or ley ground barley: "but (ſays our author) there are no eſtabliſhed rules reſpecting any part of the culture of this time-ſerving crop." The culture of the ground is uſually the ſame with that of barley; the ground generally undergoing a winter fallow of three or four ploughings, though ſometimes they are ſown after one ploughing. They are more commonly ſown

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above furrow than barley. The ſeed-time is made ſubſervient to that of barley, being ſometimes ſooner and ſometimes later than barley ſeed-time: and Mr Marſhal obſerves, that he has ſometimes ſeen them ſown in June; it being obſervable, that oats ſown late ripen earlier than barley ſown at the ſame time. The quantity of ſeed in Norfolk is from four to five buſhels per acre; but he does not acquaint us with the produce. He mentions a very ſingular method of culture ſometimes practiſed in this county, viz. ploughing down the oats after they begin to vegetate, but before they have got above ground: which is attended with great ſucceſs, even though the ground is turned over with a full furrow. By this method weeds of every kind are deſtroyed, or at leaſt checked in ſuch a manner as to give the crop an opportunity of getting above them. As the poroſity communicated to the ſoil is excellently well adapted to the infant plants of barley; that grain probably might frequently receive benefit from this operation.

Method of ploughing down oats.

Wild oats a weed in the Vale of Glouceſter.

In the Vale of Glouceſter, Mr Marſhal obſerves, that the wild oat is a very troubleſome weed, as well as in Yorkſhire; and he is of opinion, that it is as truly a native of Great Britain as any other arable weed, and is perhaps the moſt difficult to be extirpated. It will lie a century in the ſoil without loſing its vegetative quality. Ground which has lain in a ſtate of graſs time immemorial, both in Glouceſter and Yorkſhire, has produced it in abundance on being broken up. It is alſo endowed with the ſame ſeemingly inſtinctive choice of ſeaſons and ſtate of the ſoil as other ſeeds of weeds appear to have. Hence it is exceſſively difficult to be overcome; for as it ripens

before

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before any crop of grain, it ſheds its ſeeds on the ſoil, where the roughneſs of its coat probably ſecures it from birds. The only methods of extirpating this plant are fallowing, hoeing, and handweeding, where the laſt is practicable, after it has ſhot its panicle.

Oats not cultivated in the Vale of Glouceſter.

No oats are cultivated in the Vale of Glouceſter; though the wild oat grows everywhere, as already ſaid. Mr Marſhal is of opinion that the ſoil is better adapted to oats than to barley. The reaſon he aſſigns for the preference given to the latter is, that in this part of the country the monks were formerly very numerous, who probably preferred *ale* to oaten cake.—He now, however, recommends a trial of the grain on the ſtronger cold lands in the area of the Vale, as they ſeldom can be got ſufficiently fine for barley. The fodder from oats he accounts much more valuable than that from barley to a dairy country; and the grain would more than balance in quantity the comparative difference in price.

Cultivation in the Midland diſtrict.

In the midland diſtrict the *Poland oat*, which was formerly in vogue, has now given place to the *Dutch* or *Frieſland* kind. It is conſtantly ſown after turf; one ploughing being given in February, March, or April. The ſeed-time is the latter end of March and beginning of April, from four to ſeven buſhels an acre; the produce is in proportion to the ſeed, the medium being about ſix quarters.

In Yorkſhire.

In Yorkſhire the Frieſland oats are likewiſe preferred to the Poland, as affording more ſtraw, and being thinner ſkinned than the latter. The *Siberian*, or *Tartarian* oat, a ſpecies unnoticed by Linnæus, is likewiſe cultivated in this country: the *reed* oat is known, but has not yet come into any great eſtimation. The grain is light, and the ſtraw too ready to be affected by cattle.

Oats are particularly cultivated in the weſtern diviſion of the Vale of Yorkſhire; where the ſoil is chiefly a rich ſandy loam, unproductive of wheat. Five or ſix buſhels, or even a quarter of oats, are ſometimes ſown upon an acre; the produce from ſeven to ten quarters. In this country they are thraſhed in the open air, and frequently even upon the bare ground, without even the ceremony of interpoſing a cloth. The reaſons aſſigned for this ſeemingly ſtrange practice are, that if pigs and poultry be employed to eat up the grain which eſcapes the broom, there will be little or no waſte. Here the market is always very great for new oats, the manufacturing parts of Weſt Yorkſhire uſing principally oat-bread. The only objection to this practice is the chance of bad weather; but there is always plenty of ſtraw to cover up the thraſhed corn, and it is found that a little rain upon the ſtraw does not make it leſs agreeable to cattle.

Singular method of thraſhing.

In an experiment made by Mr Bartley* near Briſtol, upon black oats, we are informed that he had the prodigious increaſe of 98¼ Wincheſter buſhels from four on the acre: the land was a deep, mellow, ſandy loam. It had carried potatoes the former year, and received one ploughing for a winter fallow. Another ploughing was given it in February, and the ſeed was ſown on the 27th and 28th of the month. The ſucceſs of the experiment was ſuppoſed to be owing partly to the early ſowing and partly to a good deep tillage.

Experiment on black oats.

3. BARLEY.

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* *Bath Papers*, vol. iv. p. 281.

3. BARLEY.

Culture of Barley.

This is a culmiferous plant that requires a mellow ſoil. Upon that account, extraordinary care is requiſite where it is to be ſown upon clay. The land ought to be ſtirred immediately after the foregoing crop is removed, which lays it open to be mellowed by the froſt and air. In that view, a peculiar ſort of ploughing has been introduced, termed *ribbing*; by which the greateſt quantity of ſurface poſſible is expoſed to the air and froſt. The obvious objection to this method is, that half of the ridge is left unmoved. And to obviate that objection, the following method is offered, which moves the whole ſoil, and at the ſame time expoſes the ſame quantity of ſurface to the froſt and air. As ſoon as the former crop is off the field, let the ridges be gathered with as deep a furrow as the ſoil will admit, beginning at the crown and ending at the furrows. This ploughing looſens the whole ſoil, giving free acceſs to the air and froſt. Soon after, begin a ſecond ploughing in the following manner: Let the field be divided by parallel lines croſs the ridges, with intervals of thirty feet or ſo. Plough once round an interval, beginning at the edges, and turning the earth toward the middle of the interval; which covers a foot or ſo of the ground formerly ploughed. Within that foot plough another round ſimilar to the former; and, after that, other rounds, till the whole interval be finiſhed, ending at the middle. Inſtead of beginning at the edges, and ploughing toward the middle, it will have the ſame effect to begin at the middle, and to plough toward the edges. Plough the other intervals in the ſame manner. As by this operation the furrows

Ribbing.

A better method.

of the ridges will be pretty much filled up, let them be cleared and water-furrowed without delay. By this method, the field will be left waving like a plot in a kitchen garden, ridged up for winter. In this form, the field is kept perfectly dry; for beſides the capital furrows that ſeparate the ridges, every ridge has a number of croſs furrows that carry the rain inſtantly to the capital furrows. In hanging grounds retentive of moiſture, the parallel lines above mentioned ought not to be perpendicular to the furrows of the ridges, but to be directed a little downward, in order to carry rain water the more haſtily to theſe furrows. If the ground be clean, it may lie in that ſtate winter and ſpring, till the time of ſeed-furrowing. If weeds happen to riſe, they muſt be deſtroyed by ploughing, or braking, or both; for there cannot be worſe huſbandry, than to put the ſeed into dirty ground.

Advantages of this method.

This method reſembles common ribbing in appearance, but is very different in reality. As the common ribbing is not preceded by a gathering furrow, the half of the field is left untilled, compact as when the former crop was removed, impervious in a great meaſure to air or froſt. The common ribbing at the ſame time lodges the rain-water on every ridge, preventing it from deſcending to the furrows; which is hurtful in all ſoils, and poiſonous in a clay ſoil. The *ſtitching* here deſcribed, or *ribbing*, if you pleaſe to call it ſo, prevents theſe noxious effects. By the two ploughings the whole ſoil is opened, admitting freely air and froſt; and the multitude of furrows lays the ſurface perfectly dry, giving an early opportunity for the barley-ſeed.—But further, as to the advantage of this method: When it is proper to ſow the ſeed, all is laid flat with the

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the brake, which is an eaſy operation upon ſoil that is dry and pulverized; and the ſeed-furrow which ſucceeds is ſo ſhallow as to bury little or none of the ſurface earth: whereas the ſtirring for barley is commonly done with the deepeſt furrow; and conſequently buries all the ſurface ſoil that was mellowed by the froſt and air. Nor is this method more expenſive; becauſe the common ribbing muſt always be followed with a ſtirring furrow, which is ſaved in the method recommended. Nay, it is leſs expenſive; for after common ribbing, which keeps in the rain-water, the ground is commonly ſo ſoured, as to make the ſtirring a laborious work.

Management of ſeed in a dry ſeaſon.

It is well known that barley is leſs valuable when it does not ripen equally; and that barley which comes up ſpeedily in a duſky ſoil, muſt gain a great advantage over ſeed-weeds. Therefore, firſt take out about one-third of the contents of the ſacks of ſeed-barley or bear, to allow for the ſwelling of the grain. Lay the ſacks with the grain to ſteep in clean water; let it lie covered with it for at leaſt 24 hours. When the ground is extremely dry, and no likelihood of rain for 10 days, it is better to lie 36 hours; ſow the grain wet from ſteeping, without any addition of powdered quicklime, which, though often recommended in print, can only poiſon the ſeed, ſuck up part of its uſeful moiſture, and burn the hand of the ſower. The ſeed will ſcatter well, as clean water has no tenacity; only the ſower muſt put in a fourth or a third more ſeed in bulk than is uſual of dry grain, as the grain is ſwelled in that proportion: harrow it in as quickly as poſſible after it is ſown; and though not neceſſary, give

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it the benefit of a freſh furrow, if convenient.' You may expect it up in a fortnight at fartheſt.

It ought to be underſtood as a general principle, that of all preparations for barley, the beſt is a crop of turnips properly cultivated during the preceding year. Upon a clayey ſoil, however, it is abſolutely neceſſary that theſe ſhould not be conſumed upon the field, on account of the additional tenacity which ſuch a ſoil would acquire from being poached by the feet of cattle during wet weather. The dung in this caſe ought to be reſtored to the land. On lighter ſoils the turnip crop may be conſumed in the field; though this is a practice by no means to be recommended where a contrary mode can conveniently be adopted.

The following experiment by a correſpondent of the Bath Society being conſidered as a very intereſting one, is here ſubjoined.

nportant xperi-ents on ed-barley

"The laſt ſpring (1783) being remarkably dry, I ſoaked my ſeed-barley in the black water taken from a reſervoir which conſtantly receives the draining of my dung heap and ſtables. As the light corn floated on the top, I ſkimmed it off, and let the reſt ſtand 24 hours. On taking it from the water, I mixed the ſeed grain with a ſufficient quantity of ſifted wood-aſhes, to make it ſpread regularly, and ſowed three fields with it. I began ſowing the 16th, and finiſhed the 23d of April. The produce was 60 buſhels per acre, of good clean barley, without any *ſmall* or *green* corn, or weeds, at harveſt. No perſon in this country had better grain.

I ſowed alſo ſeveral other fields with the ſame ſeed dry, and without any preparation; but the crop, like thoſe of my neighbours, was very poor; not more than twenty buſhels per acre, and much mixed with *green* corn and weeds when harveſted, I alſo ſowed ſome of the ſeed dry on one ridge in each of my former fields, but the produce was very poor in compariſon of the other parts of the field."

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Where the land is in good order, and free of weeds, April is the month for ſowing barley. Every day is proper, from the firſt to the laſt.

Time of ſowing.

The dreſſing loamy ſoil and light ſoil for barley, is the ſame with that deſcribed; only that to plough dry is not altogether ſo eſſential as in dreſſing clay ſoil. Loam or ſand may be ſtirred a little moiſt: better, however, delay a week or two, than to ſtir a loam when wet. Clay muſt never be ploughed moiſt, even though the ſeaſon ſhould eſcape altogether. But this will ſeldom be neceſſary; for not in one year of 20 will it happen, but that clay is dry enough for ploughing ſome time in May. Froſt may correct clay ploughed wet after harveſt; but when ploughed wet in the ſpring, it unites into a hard maſs, not to be diſſolved but by very hard labour.

On the cultivation of this grain we have the following obſervations by a Norfolk farmer.

Miſcellaneous obſervations concerning the cultivation of barley.

The beſt ſoil, he obſerves, is that which is dry and healthy, rather light than ſtiff, but yet of ſufficient tenacity and ſtrength to retain the moiſture. On this kind of land the grain is always the beſt bodied and coloured, the nimbleſt in the hand, and has the thinneſt rind. Theſe are qualities which recommend it moſt to the maltſter. If the land is poor, it ſhould be dry and warm; and when ſo, it will often bear better corn than richer land in a cold and wet ſituation.

In the choice of your ſeed, it is needful to obſerve, that

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that the beſt is of a pale lively colour, and brightiſh caſt, without any deep redneſs or black tinge at the tail. If the rind be a little ſhrivelled, it is the better; for that ſlight ſhrivelling proves it to have a thin ſkin, and to have ſweated in the mow. The neceſſity of a change of ſeed by not ſowing two years together what grew on the ſame ſoil, is not in any part of huſbandry more evident than in the culture of this grain, which, if not frequently changed, will grow coarſer and coarſer every ſucceeding year.

It has generally been thought, that ſeed-barley would be benefited by ſteeping; but liming it has, in many inſtances, been found prejudicial. Sprinkling a little ſoot with the water in which it is ſteeped has been of great ſervice, as it will ſecure the ſeed from inſects. In a very dry ſeed-time, barley that has been wetted for malting, and begins to ſprout, will come up ſooner, and produce as good a crop as any other.

If you ſow after a fallow, plough three times at leaſt. At the firſt ploughing, lay your land up in ſmall ridges, and let it remain ſo during the winter, for the froſt to mellow it; the ſecond ploughing ſhould be the beginning of February. In March ſplit the ridges, and lay the land as flat as poſſible, at the ſame time harrowing it fine. But in ſtrong wet lands (if you have no other for barley) lay it round, and make deep furrows to receive the water.

"I have often (continues he), taken the following method with ſucceſs: On lands tolerably manured, I ſowed clover with my barley, which I reaped at harveſt; and fed the clover all the following winter, and from ſpring to July, when I fallowed it till the following ſpring, and then ſowed it with barley and clover

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as before. Repeating this method every year, I had very large crops, but would not recommend this practice on poor light land.

"We ſow on our lighteſt lands in April, on our moiſt lands in May; finding that thoſe lands which are the moſt ſubject to weeds produce the beſt crops when ſown late.

"The common method is to ſow the barley-ſeed broad-caſt at two ſowings; the firſt harrowed in once, the ſecond twice; the uſual allowance from three to four buſhels per acre. But if farmers could be prevailed on to alter this practice, they would ſoon find their account in it. Were only half the quantity ſown equally, the produce would be greater, and the corn leſs liable to lodge: For when corn ſtands very cloſe, the ſtalks are drawn up weak; and on that account are leſs capable of reſiſting the force of winds, or ſupporting themſelves under heavy rains.

"From our great ſucceſs in ſetting and drilling wheat, ſome of our farmers tried theſe methods with barley; but did not find it anſwer their expectations, except on very rich land.

"I have myſelf had 80 ſtalks on one root of barley, which all produced good and long ears, and the grain was better than any other; but the method is too expenſive for general practice. In poor land, ſow thin, or your crop will be worth little. Farmers who do not reaſon on the matter will be of a different opinion; but the fact is indiſputable."

When the barley is ſowed and harrowed in, he adviſes that the land be rolled after the firſt ſhower of rain, to break the clods. This will cloſe the earth about

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about the roots, which will be a great advantage to it in dry weather.

When the barley has been up three weeks or a month, it is a very good way to roll it again with a heavy roller, which will prevent the ſun and air from penetrating the ground to the injury of the roots. This rolling, before it branches out, will alſo cauſe it to tiller into a greater number of ſtalks; ſo that if the plants be thin, the ground will be thereby ſilled, and the ſtalks ſtrengthened.

If the blade grows too rank, as it ſometimes will in a warm wet ſpring, mowing is a much better method than feeding it down with ſheep; becauſe the ſcythe takes off only the rank tops, but the ſheep being fond of the ſweet end of the ſtalk next the root, will often bite ſo cloſe as to injure its future growth.

Cultivation of barley in Norfolk.

The county of Norfolk, according to Mr Marſhal, is peculiarly adapted to the cultivation of this grain, the ſtrongeſt ſoil not being too heavy, and the lighteſt being able to bear it; and ſo well verſed are the Norfolk farmers in the cultivation of it, that the barley of this county is deſired for ſeed throughout the whole kingdom. It is here ſown after wheat or turnips, and in ſome very light lands it is ſown after the ſecond year's ley. After wheat, the ſeed-time of the latter being finiſhed, and the ſtubble trampled down with bullocks, the land is ploughed with a ſhallow furrow for a winter fallow for barley. In the beginning of March the land is harrowed and croſs-ploughed; or if it be wet, the ridges are reverſed. In April it receives another ploughing lengthwiſe; and at ſeed-time it is harrowed, rolled, ſowed, and the ſurface rendered as ſmooth and level as poſſible. After turnips the ſoil is broken

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broken up as faſt as the turnips are taken off; if early in winter by *rice-balking*, a practice already explained; but if late, by a plain ploughing. It is common, if time will permit, to plough three times; the firſt ſhallow, the ſecond full, and the third a mean depth; with which laſt the ſeed is ploughed in. Sometimes, however, the ground is ploughed only once, and the ſeed ſown above; but more frequently by three ploughings, though, perhaps, the farmer has not above a week to to perform them in. After ley, the turf is generally broken by a winter fallow, and the ſoil treated as after wheat.

This grain is ſeldom manured for, except when ſown after ley, when it is treated as wheat. No manure is requiſite after turnips or wheat, if the latter has been manured for. If not, the turnip crop following immediately, the barley is left to take its chance, unleſs the opportunity be embraced for winter marling.

Little barley is ſown by the Norfolk farmers before the middle of April, and the ſeed-time generally continues till the middle of May; though this muſt in ſome meaſure depend on the ſeaſon; which, ſays Mr Marſhal, is more attended to in Norfolk than perhaps in all the world beſides." In the very backward ſpring of 1782, barley was ſown in June with ſucceſs. No preparation is uſed. It is all ſown broadcaſt, and almoſt all under furrow; that is, the ſurface having been ſmoothed by the harrow and roller, the ſeed is ſown and ploughed under with a ſhallow furrow; but if the ſeaſon be wet, and the ſoil cold and heavy, it is ſometimes ſown above: but, if the ſpring be forward, and the laſt piece of turnips eaten off late, the ground is ſometimes obliged to be ploughed only once, and to be ſown above; though in this caſe Mr Marſhal thinks it the moſt eligible management, inſtead of turning over the whole thickneſs of the ſoil, to *two-furrow* it, and ſow between. This is done by only ſkimming the ſurface with the firſt plough, ſowing the ſeed upon this, and then covering it with the bottom furrow brought up by the ſecond plough. Three buſhels are uſually ſufficient for an acre.

The barley, as well as the wheat, in Norfolk, is allowed to ſtand till very ripe. It is univerſally mown into ſwath, with a ſmall bow fixed at the heel of the ſcythe. If it receive wet in the ſwath in this county, it is not turned, but *lifted*; that is, the heads or ears are raiſed from the ground, either with a fork or the teeth of a rake, thereby admitting the air underneath the ſwaths; which will not fall down again to the ground ſo cloſe as before, ſo that the air has free acceſs to the under ſide; and this method of lifting is ſuppoſed not to be inferior to that of turning, which requires more labour, beſides breaking and ruffling the ſwaths.

In the Vale of Glouceſter.

In the Vale of Glouceſter the quantity of barley cultivated is very inconſiderable; the only ſpecies is the common long-eared barley, (*hordeum zeocriton*). In this county the grain we ſpeak of is uſed, on the every year's lands, as a cleanſing crop. It is ſown very late, viz. in the middle or end of May; ſometimes the beginning or even the middle of June The reaſon of this is, that the people of the Vale think, that if a week or ten days of fine weather can be had for the operation of harrowing out couch, and if after this a full crop of barley ſucceed, eſpecially if it ſhould fortunate-

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ly take a reclining poſture, the buſineſs of fallowing is effectually done, inſomuch that the ſoil is cleaned to a ſufficient degree to laſt for a number of years. A great quantity of ſeed is made uſe of, viz. from three to four buſhels to an acre; under the idea, that a full crop of barley, eſpecially if it lodge, ſmothers all kinds of weeds, couch-graſs itſelf not excepted. Our author acknowledges this effect in ſome degree, but does not recommend the practice. "If the land, ſays he, be tolerably clean, and the ſeaſon favourable, a barley fallow may no doubt be of eſſential ſervice. But there is not one year in five in which even land which is tolerably clean can be ſown in ſeaſon, and at the ſame time be much benefited by it for future crops." The barley in this county is all hand-weeded. It is harveſted looſe, mown with the naked ſcythe, lies in ſwath till the day of carrying, and is cocked with common hay forks. The medium produce is three quarters per acre. Its quality is preferable to that of the hill barley.

In Cotſwold.

The common long-eared ſpecies is ſown among the Cotſwold hills. It is ſown in the latter end of March and beginning of April, in the quantity of three buſhels to an acre, producing from 20 buſhels to four quarters to an acre; "which, ſays our author, is a low produce. It muſt be obſerved, however, that this produce is from land deficient in tillage; and that barley delights in a fine pulverous tilth."

In the midland diſtrict.

In the midland diſtrict they cultivate two ſpecies of barley, viz. the *zeocriton* or common long-eared, and the *diſtichon*, or ſprat barley; the latter not being of more than 50 years ſtanding, but the former of much older date. The ſprat is the more hardy, and requires

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ſummer 1787.—After ſpring feedings, a crop of turnip-rooted cabbage, or vetches, there will be ſufficient time to ſow the land with buck-wheat. Probably, in hot dry ſummers, a crop of vetches might even be mown for hay early enough to introduce a crop of this grain after it.

In the year 1780, about ſeven acres of a ſandy ſoil on Briſlington common *, having been firſt tolerably well cleanſed from brambles, furze, &c. received one ploughing. To reduce the irregularities of the ſurface, it was rolled; and on the 9th of June in that year, two buſhels and a half of buck-wheat per acre ſown, the ground rolled again without harrowing.

Advantages of this cropping.

The vegetation appeared in five or ſix days, as is conſtantly the caſe, be the weather wet or dry. The growth was ſo rapid, that the fern, with which this land greatly abounded, was completely kept under. About the middle of September the crop was mown; but by reaſon of a great deal of rain about that time it was not ſecured until the beginning of October; hence a loſs of a great part of the grain by ſhedding, as well as ſome eaten by birds. However, there were ſaved about 24 Wincheſter buſhels per acre; and, notwithſtanding its long expoſure to the weather, it received no ſort of damage, only perhaps that the fineſt and moſt perfect grain was the firſt to fall from the plant. The ground after this had almoſt the appearance of a fallow, and was immediately ploughed.

When it had lain a moderate time to meliorate, and to receive the influences of the atmoſphere, it was harrowed,

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* A very rough piece of land, at that time juſt encloſed.

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rowed, ſown with Lammas wheat, and ploughed in under furrow, in a contrary direction to the firſt ploughing. Thus a piece of land, which in the month of April was altogether in a ſtate of nature, in the following November was ſeen under a promiſing crop of what is well ſtyled the king of grain, and this without the aid of manure, or of any very great degree of tillage. Nor was the harveſt by any means deficient; for ſeveral perſons converſant in ſuch things eſtimated the produce from 26 to 30 buſhels per acre. As ſoon as the wheat crop was taken off, the ground had one ploughing, and on the firſt of September following was ſown with turnip ſeed. The turnips were not large, but of an herbage ſo abundant as in the following ſpring to ſupport 120 ewes with their lambs, which were fed on it by folding four weeks. After this it was manured with a compoſition of rotten dung and natural earth, about 20 putt loads per acre, and planted with potatoes. The crop ſold for 138l. beſides a conſiderable number uſed in the family, and a quantity reſerved with which ten acres were planted the following ſeaſon. The enſuing autumn it was again ſown with wheat, and produced an excellent crop. In the ſpring of 1784, it was manured and planted with potatoes, as in the preceding inſtance; the crop (though tolerably good) by no means equal to the former, producing about 100 ſacks per acre only. In ſpring 1785, the land was now for a third time under a crop of wheat, it being intended to try how far this mode of alternate cropping, one year with potatoes and another with wheat, may be carried.

From the ſucceſs of the preceding and other experiments, by Nehemiah Bartley, Eſq. of Briſtol, as de-

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tailed in the Bath Society Papers, it would ſeem, that the culture of this plant ought in many caſes to be adopted inſtead of a ſummer-fallowing: for the crop produced appears not only to be ſo much clear gain in reſpect to ſuch practice, but alſo affords a conſiderable quantity of ſtraw for fodder and manure; beſides that a ſummer-fallowing is far from being ſo advantageous a preparation for a ſucceeding crop.

5. PEASE.

Culture of Peaſe.

Peaſe are of two kinds; the white and the gray. The cultivation of the latter only belongs, in ſtrictneſs, to this place.

There are two ſpecies of the gray kind, diſtinguiſhed by their time of ripening. One ripens ſoon, and for that reaſon is termed *hot ſeed;* the other, which is ſlower in ripening, is termed *cold ſeed.*

Peaſe, a leguminous crop, is proper to intervene between two culmiferous crops; leſs for the profit of a peaſe crop than for meliorating the ground. Peaſe, however, in a dry ſeaſon, will produce ſix or ſeven bolls each acre; but, in an ordinary ſeaſon, they ſeldom reach above two, or two and a half. Hence, in a moiſt climate, which all the weſt of Britain is, red clover ſeems a more beneficial crop than peaſe; as it makes as good winter food as peaſe, and can be cut green thrice during ſummer.

A field intended for cold ſeed ought to be ploughed in October or November; and in February, as ſoon as the ground is dry, the ſeed ought to be ſown on the winter furrow. A field intended for hot ſeed ought to be ploughed in March or April, immediately before ſowing.

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ing. But if infeſted with weeds, it ought to be alſo ploughed in October or November.

Peaſe laid a foot below the ſurface will vegetate; but the moſt approved depth is ſix inches in light ſoil, and four inches in clay ſoil; for which reaſon, they ought to be ſown under furrow when the ploughing is delayed till ſpring. Of all grains, beans excepted, they are the leaſt in danger of being buried.

Horſe-hoeing of peaſ

Peaſe differ from beans, in loving a dry ſoil and a dry ſeaſon. Horſe-hoeing would be a great benefit, could it be performed to any advantage; but peaſe grow expeditiouſly, and ſoon fall over and cover the ground, which bars ploughing. Horſe-hoeing has little effect when the plants are new ſprung; and when they are advanced ſo as to be benefited by that culture, their length prevents it. Faſt growing at the ſame time is the cauſe of their carrying ſo little ſeed: the ſeed is buried among the leaves; and the ſun cannot penetrate to make it grow and ripen. The only practicable remedy to obtain grain, is thin ſowing; but thick ſowing produces more ſtraw, and mellows the ground more. Half a boll for an Engliſh acre may be reckoned thin ſowing; three firlots thick ſowing.

Notwithſtanding what is ſaid above, the late Mr Hunter, a noted farmer in Berwickſhire, was accuſtomed to ſow all his peaſe in drills; and never failed to have great crops of corn as well as of ſtraw. He ſowed double rows at a foot interval, and two feet and a half between the double rows, which admit horſe-hoeing. By that method, he had alſo good crops of beans on light land.

Peaſe and beans mixed are often ſown together, in order to catch different ſeaſons. In a moiſt ſeaſon,

ſon, the beans make a good crop; in a dry ſeaſon, the peaſe.

The growth of plants is commonly checked by drought in the month of July; but promoted by rain in Auguſt. In July, graſs is parched; in Auguſt, it recovers verdure. Where peaſe are ſo far advanced in the dry ſeaſon as that the ſeed begins to form, their growth is indeed checked, but the ſeed continues to fill. If only in the bloſſom at that ſeaſon, their growth is checked a little; but they become vigorous again in Auguſt, and continue growing without filling till ſtopped by froſt. Hence it is, that cold ſeed, which is early ſown, has the beſt chance to produce corn: hot ſeed, which is late ſown, has the beſt chance to produce ſtraw.

The following method is practiſed in Norfolk, for ſowing peaſe upon a dry light ſoil, immediately opened from paſture. The ground is pared with a plough extremely thin, and every ſod is laid exactly on its back. In every ſod a double row of holes is made. A pea dropt in every hole lodges in the flayed ground immediately below the ſod, thruſts its roots horizontally, and has ſufficient moiſture. This method enabled Norfolk farmers, in the barren year 1740, to furniſh white peaſe at 12s. per boll.

Experiments on ſetting peaſe in drills.

In the Bath Papers, vol. i. p. 148. we have an account of the ſucceſs of an experiment by Mr Pavier near Taunton, on ſowing peaſe in drills. The ſcale on which this experiment was made, however, being ſo ſmall, it would perhaps be raſh to infer from it what might be the event of planting a large piece of ground in the ſame manner. The ſpace was only 16 ſquare yards, but the produce ſo great, that by calculating

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culating from it, a ſtatute acre would yield 600, or at the leaſt 500 pecks of green peaſe at the firſt gathering; which, at the high price they bore at that time in the country about Taunton, viz. 16d. per peck, would have amounted to 33l. 6s. 8d. On this the Society obſerved, that though they doubt not the truth of the calculation, they are of opinion, that ſuch a quantity as 500 or 600 pecks of green peaſe would immediately reduce the price in any country market. "If the above-mentioned crop (ſay they) were ſold only at nine pence per peck, the farmer would be well paid for his trouble." In a letter on the drill huſbandry by Mr Whitmore, for which the thanks of the Society were returned, he informs us, that drilled peaſe muſt not be ſown too thin, or they will always be foul: and in an experimet of this kind, notwithſtanding careful hoeing, they turned out ſo foul, that the produce was only eight buſhels to the acre.—From an experiment related in the 5th volume of the ſame work, it appears that peaſe, however meliorating they may be to the ground at firſt, will at the laſt totally exhauſt it, at leaſt with regard to themſelves. In this experiment they were ſown on the ſame ſpot for ten years running. After the firſt two years the crop became gradually leſs and leſs, until at laſt the ſeed would not vegetate, but became putrid. Strawberries were then planted without any manure, and yielded an excellent crop.

Peaſe muſt not be ſown too often on the ſame ſpot.

Mr Marſhal's obſervations.

On the Norfolk culture of peaſe, Mr Marſhal makes two obſervations. "Leys are ſeldom ploughed more than once for peaſe; and the ſeed is in general dibbled in upon the flag of this one ploughing. But ſtubbles are in general broken by a winter-fallow of

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three or four ploughings; the ſeed being ſown broadcaſt and ploughed in about three inches deep with the laſt ploughing."—In the Vale of Glouceſter they are planted by women, and hoed by women and children, once, twice, and ſometimes thrice; which gives the crop, when the ſoil is ſufficiently free from root-weeds, the appearance of a garden in the ſummer time, and produces a plentiful crop in harveſt. The diſtance between the rows varies from 10 to 14 inches, but 12 may be conſidered as the medium; the diſtance in the rows two inches. In the Cheltenham quarter of the diſtrict, they ſet the peaſe not in continued lines, but in clumps; making the holes eight or ten inches diſtant from one another, putting a number of peaſe into each hole. Thus the hoe has undoubtedly greater freedom; all the diſadvantage is, that in this caſe the ſoil is not ſo evenly and fully occupied by the roots as when they are diſpoſed in continued lines.—In Yorkſhire it is common to ſow beans and gray peaſe together, under the name of *blendings*; and ſometimes vetches (probably, ſays Mr Marſhal, a gigantic variety of the *ervum lens*) are ſown among beans. Such mixtures are found to augment the crop, and the different ſpecies are eaſily ſeparated by the ſieve.

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A Suffolk farmer has given the following remarks upon the culture of peaſe, ſome of which are very worthy of attention. He enumerates eight kinds: "1. The common white. 2. The forty-day. 3. The Charlton. 4. The blue. 5. The large gray. 6. The ſmall gray. 7. The ſpeckled. 8. The large Dutch." Between the three firſt of theſe he repreſents the diſtinction as not very clear. "The gray hog pea, he adds, whether large or ſmall, will bear being ſown in autumn; a common practice in Hertfordſhire, where they begin pea-ſowing as ſoon as the wheat ſeed is over. The farmers, however, have diſtinctions, and think that ſome ſorts will ſtand the winter, and that others will not; but I never could gain explicit information upon this head ſufficient to overthrow my own practice: for I have ſown them all in November more than once with ſucceſs. The blue and ſpeckled, I believe, are ſpring peaſe. All that I know of the Dutch is, that a perſon had them from Holland; they are as large as a horſe-bean, and ſucceeded well with him.

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* *Annals of Agriculture*, vol. xxxiii.

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"Of all other preparations for peaſe, that is beſt which admits the leaſt tillage, viz. ley ground, with only one ploughing, the peaſe to be pricked in with iron dibblers, a common method in Suffolk, and which ſucceeds greatly; but it ſhould be practiſed only on loams and good ſand; very poor ſand will not do for peaſe, and on clay beans anſwer far better. When this preparation is not followed, but the crop put in on a ſtubble, the land ſhould be ploughed in autumn, and, if the ſeaſon demands it, twice in the ſpring; but one ploughing, judiciouſly timed, may do better than two. The ſeed may be either ploughed or harrowed; if the former, it muſt not be above three inches deep; but harrowing in is ſafer, if the harrows let them in two inches. If harrowed in, they muſt be watched againſt rooks, &c.

"As no manuring ſhould be given for peaſe, I paſs on to the time of putting them into the ground; and here it is neceſſary to reject the autumnal ſowing, when the

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the crop is to be harveſted time enough for turnips. In that caſe, I recommend it only for dry lands. The ſort which are ſown before Chriſtmas are late peaſe, which are not off ſoon enough for this purpoſe. The forty-day, or the Charlton pea, ſhould be ſown early in March; and if turnips are intended, not later than that month. Late ſown crops are ſubject to the green fly. If they are not intended as a preparation for turnips then the time of ſowing is before Chriſtmas; but to choose a dry time, for if they are ſown ſoon after rain or ſnow, the crop will ſuffer.

" I would never ſow broad-caſt leſs than three buſhels an acre of peaſe. One great object, perhaps the greateſt in this crop, is to procure a thick cover over the ſoil; which, if thick enough, deſtroys weeds very effectually, and breeds a moiſt putrid fermentation on the ſurface of the land; this is never effected with a thin crop. If you look only to the produce, and deſign to have the hoes perpetually at work, two buſhels and even leſs are enough.

" Peaſe when ripe are very apt to be devoured by rooks, wood-pigeons, and other birds; they ſhould therefore be well watched. The beſt way of cutting them is with the tool called a peaſe-make, made with half an old ſcythe; and, as cut, they are turned up into wads or bundles, which ſhould lie out ſome days to wither. Theſe wads ſhould be ſmall, for they do not dry well when large. Peaſe are ſometimes mown, but it is a very bad practice.

Early peaſe are recommended by this writer as a preparation for turnips. " By ſowing the charlton or forty-day pea early in March, they will be cleared from the field within the month of June, or the firſt week of

July, which is a very good ſeaſon for turnips, and on all dry ſoils (the only ones proper for peaſe) ought never to be neglected. If the harveſt happens to be later, the wads ſhould be laid in rows, and the ploughs ſent in without waiting for their being cleared away; by which a week or perhaps ten days may be gained. The advantages of this practice muſt be obvious, when it is conſidered that a thick ſmothering crop of peaſe, not only kills weeds, but improves the ſoil, and particularly in leaving the ſurface looſe and friable from the putrefactive fermentation carried on under the peaſe, which retain moiſture but exclude the ſun; and if the land is ploughed directly, which is a great point, though much neglected by farmers in general, proves a fine preparation for turnips. The peaſe are not the only gain, but the ſaving in tillage; for by this means the latter crop is put in upon only one ploughing, which can be effected no other way."

6. BEANS.

The propereſt ſoil for beans is a moiſt and deep clay, but they may alſo be raiſed upon all heavy ſoils. They are cultivated in two ways; either in the old way by broad-caſt, or, according to the more recent practice, they are drilled in diſtinct rows. Of each of theſe we ſhall give a very ſhort account.

Culture of beans by broad-caſt.

When the mode of cultivating beans by broad-caſt is adopted, it is to be obſerved, that as this grain is early ſown, the ground intended for it ſhould be ploughed before winter, to give acceſs to the froſt and air; beneficial in all ſoils, and neceſſary in a clay ſoil. Take the firſt opportunity after January, when the ground is dry, to looſen the ſoil with the harrow firſt deſcribed, till a mould be brought upon it. Sow the ſeed, and cover it with the ſecond harrow. The third will ſmooth the ſurface, and cover the ſeed equally. Theſe harrows make the very beſt figure in ſowing beans: which ought to be laid deep in the ground, not leſs than ſix inches. In clay ſoil, the common harrows are altogether inſufficient. The ſoil, which has reſted long after ploughing, is rendered compact and ſolid: the common harrows ſkim the ſurface: the ſeed is not covered; and the firſt hearty ſhower of rain lays it above the ground. Where the farmer overtakes not the ploughing after harveſt, and is reduced to plough immediately before ſowing, the plough anſwers the purpoſe of the firſt harrow; and the other two will complete the work. But the labour of the firſt harrow is ill ſaved; as the ploughing before winter is a fine preparation, not only for beans, but for grain of every kind. If the ground ploughed before winter happen by ſuperfluity of moiſture to cake, the firſt harrow going along the ridges, and croſſing them, will looſen the ſurface, and give acceſs to the air for drying. As ſoon as the ground is dry, ſow without delaying a moment. If rain happen in the interim, there is no remedy but patience till a dry day or two come.

Carſe clay, ploughed before winter, ſeldom fails to cake. Upon that account, a ſecond ploughing is neceſſary before ſowing: which ought to be performed with an ebb furrow, in order to keep the froſt-mould as near the ſurface as poſſible. To cover the ſeed with the plough is, with regard to this as well as other grain, expreſſed by the phraſe *to ſow under furrow.* The clods raiſed in this ploughing are a ſort of ſhelter to the young plants in the chilly ſpring months.

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The foregoing method will anſwer for loam. And as for a ſandy or gravelly ſoil, it is altogether improper for beans.

Culture of beans in drills.

Previous to the year 1770, beans were ſeldom ſown in Scotland, unleſs upon the very rich clays; but ſince that time, by adopting the plan of raiſing them in drills, or diſtinct rows, they have been ſucceſsfully cultivated upon all the heavy loams, and in many farms they now conſtitute a regular branch of rotation. With very few exceptions, beans are conſtantly drilled at intervals of from 20 to 27 inches. Of theſe modes, the laſt is the moſt prevalent, becauſe it admits the ground to be ploughed with a horſe, in the moſt ſufficient manner. Very little hand-hoing is given; nor is it required, as the kind of land which is beſt adapted for their growth, and upon which they are commonly ſown, has not naturally a tendency to the production of annual weeds; and fine crops of wheat generally follow, provided due attention has been given to working the bean crop. The neceſſity of ſummer fallow, which the preſent high price of labour, and the loſs of a year's crop, render an expenſive affair to the farmer, is conſequently much leſſened: for if land is once thoroughly cleaned, and afterwards kept in an alternate courſe of leguminous and culmiferous crops, it will remain in good order for a conſiderable number of years.

As beans delight in a moiſt ſoil, and have no end of growing in a moiſt ſeaſon, they cover the ground totally when ſown broad-caſt, keep in the dew, and exclude the ſun and air: the plants grow to a great height; but carry little ſeed, and that little not well ripened. This diſplays the advantage of drilling; which

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which gives free acceſs to the ſun and air, dries the ground, and affords plenty of ripe ſeed.

The following remarks upon the ſubject made by Mr Vancouver * are alſo worthy of attention. " The land upon which peaſe or tares may be cultivated to advantage, does not require to poſſeſs ſo deep a ſtaple as that appropriated to the culture of beans; the ſeed of which, in moſt ſoils, be their texture what it may, ſhould never be depoſited at a leſs depth than five or ſix inches below the ſettled ſurface of the ground. The neceſſity for placing the bean thus deep, will appear very obvious to any one who will take the trouble to inſpect the root of the bean, when the plant has attained to its full growth, and its ſeed to its complete maturity; it will then appear evident, that from the point where the ſeed was depoſited in the ground it ſends downwards a long ſlender tap root, and upwards a thick ſtrong one; along this upper diviſion of the root, lateral fibres are detached from the ſeed to the ſurface of the ground, and are evidently deſtined to collect and convey nouriſhment to the plant. The long tap-root which deſcends perpendicularly, and to a great depth from the point where the ſeed was placed in the ground, being perfectly clear of laterals, will not be ſuppoſed to contribute but in a ſmall degree to the growth and ſubſiſtence of the plant. Hence the neceſſity of placing the bean to a proper depth in the ground, that the plant may not be deprived of its proper organs for receiving and conveying from the earth that portion of nouriſhment which the bean requires; but which, as well as in the caſe of peaſe

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* *Annals of Agriculture*, vol. xxv.

peaſe or tares, will not be found equal to that conſtantly demanded and drawn from the land by turnips, cabbages, and the white ſtraw crops.

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II. *Plants Cultivated for Roots.*

1. POTATOES.

THESE, next to the different kinds of grain, may be looked upon as the crop moſt generally uſeful for the huſbandman; affording not only a moſt excellent food for cattle, but for the human ſpecies alſo.

Are not prejudicial to mankind.

In this laſt reſpect, indeed, they are extremely valuable. They are the only ſubſtitute for bread formed of grain which has hitherto been introduced with any tolerable degree of ſucceſs. They aſſume by the aſſiſtance of cookery ſuch a variety of forms as renders them at all times extremely acceptable; and they are now juſtly regarded by the public as the ſureſt reſource in all times of ſcarcity, chiefly for this reaſon, that in the Britiſh iſlands, ſurrounded as they are by the waters of the ocean, the crop of grain is chiefly found to fail in conſequence of wet ſeaſons, which do by no means affect the potato in the ſame degree.

Kinds of potatoes to be preferred.

Various kinds of potatoes have at different periods been faſhionable, and the varieties which the ſpecies is capable of exhibiting ſeems unbounded, as every perſon who takes the trouble to raiſe them from the ſeed diſcovers new ſorts. In ſelecting the kind which he is to rear, the huſbandman ought to conſider the uſe that he is to make of them. If his lands are ſituated at a diſtance from any town, which may prevent his crop from being ſold for human uſe, and confine it to the conſumption of cattle, he will probably derive moſt benefit from planting the coarſe dark red kind of potatoes called *yams*, which afford a very great produce. They are extremely valuable for milch cows, increaſing the produce without affecting the quality or taſte of the milk; they grow on poor ſoils even more abundantly than on rich, (where they are apt to run too much to ſtem, and to be leſs productive at the root) and from the conſtant verdure which they retain to the lateſt period of the ſeaſon, they are highly valuable in improving the ſtate of the ſoil.

In the choice of potatoes intended to be conſumed by man, the huſbandman ought to attend to this quality of the potato, that the kinds which afford the moſt valuable and abundant crop at the root are apt to ſend forth the leaſt luxuriant ſtems, while thoſe whoſe ſtems are very large and branchy are leſs productive at the root. Thus the kidney potato, which is much valued on account of its quality, and which on on a rich ſoil is extremely prolific, is apt to ſend out a very feeble ſtem, which affords little or no covering to the ſoil, on which account ſome of the moſt judicious huſbandmen have laid it aſide.

General culture.

The choice of ſoil is not of greater importance in any other plant than in a potato. This plant in clay ſoil, or in rank black loam lying low without ventilation, never makes palatable food. In a gravelly or ſandy ſoil, expoſed to the ſun and free air, it thrives to perfection, and has a good reliſh. But a rank black loam, though improper to raiſe potatoes for the table, produces them in great plenty; and the product is, as already obſerved, a palatable food for horned cattle, hogs, and poultry.

The ſpade is a proper inſtrument for raiſing a ſmall

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quantity, or for preparing corners or other places inacceſſible to the plough; but for raiſing potatoes in quantities, the plough is the only inſtrument.

As two great advantages of a drilled crop are, to deſtroy weeds, and to have a fallow at the ſame time with the crop, no judicious farmer will think of raiſing potatoes in any other way. In September or October, as ſoon as that year's crop is removed, let the field have a rouſing furrow, a croſs-braking next, and then be cleared of weeds by the cleaning harrow. Form it into three-feet ridges, in that ſtate to lie till April, which is the proper time for planting potatoes. Croſs-brake it, to raiſe the furrows a little. Then lay well digeſted horſe-dung along the furrows, upon which lay the roots at eight inches diſtance. Cover up theſe roots with the plough, going once round every row. This makes a warm bed for the potatoes; hot dung below, and a looſe covering above, that admits every ray of the ſun. As ſoon as the plants appear above ground, go round every row a ſecond time with the plough, which will lay upon the plants an additional inch or two of mould, and at the ſame time bury all the annuals; and this will complete the ploughing of the ridges. When the potatoes are ſix inches high, the plough, with the deepeſt furrow, muſt go twice along the middle of each interval in oppoſite directions, laying earth firſt to one row, and next to the other. And to perform this work a plough with a double mouldboard will be more expeditious. But as the earth cannot be laid cloſe to the roots by the plough, the ſpade muſt ſucceed, with which four inches of the plants muſt be covered, leaving little more but the tops above ground; and this operation will at the ſame time bury all the weeds that have ſprung ſince the former ploughing. What weeds ariſe after muſt be pulled up with the hand. A hoe is never to be uſed here: it cannot go ſo deep as to deſtroy the weeds without cutting the fibres of the plants; and if it ſkim the ſurface, it only cuts off the heads of the weeds, and does not prevent their puſhing again.

Particular methods.

In the Bath Society Papers, we have the following practical obſervations on the culture and uſe of potatoes, given as the reſult of various experiments made for five years ſucceſſively on that valuable root, the growth of which cannot be too much encouraged.

When the potato crop has been the only object in view, the following method is the moſt eligible.

The land being well pulverized by two or three good harrowings and ploughings, is then manured with 15 or 20 cart loads of dung per acre, before it receives its laſt earth. Then it is thrown into what the Suffolk farmers call the *trench balk*, which is narrow and deep ridge-work, about 15 inches from the centre of one ridge to the centre of the other. Women and children drop the ſets in the bottom of every furrow 15 inches apart; men follow and cover them with large hoes, a foot in width, pulling the mould down ſo as to bury the ſets five inches deep; they muſt receive two or three hand-hoeings, and be kept free from weeds; always obſerving to draw the earth as much as poſſible to the ſtems of the young plants. By repeated trials, the firſt or ſecond week in April is found the moſt advantageous time for planting.

In the end of September or the beginning of October, when the haulm becomes withered, they ſhould be ploughed up with a ſtrong double-breaſted plough.

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The workman muſt be cautioned to ſet his plough very deep, that he may ſtrike below all the potatoes, to avoid damaging the crop. The women who pick them up, if not carefully attended to, will leave many in the ground, which will prove detrimental to any ſucceeding corn, whether wheat or barley. To avoid which inconvenience, let the land be harrowed, and turn the ſwine in to glean the few that may be left by their negligence.

By this method, the ſets will be 15 ſquare inches from each other; it will take 18 buſhels to plant an acre; and the produce, if on a good mixed loamy ſoil, will amount to 300 buſhels.

If the potatoes are grown as a preparation for wheat, it is preferable to have the rows two feet two inches from each other, hand-hoeing only the ſpace from plant to plant in each row; then turning a ſmall furrow from the inſide of each row by a common light plough, and afterwards, with a double-breaſted plough with one horſe, ſplit the ridge formed by the firſt ploughing thoroughly to clean the intervals. This work ſhould not be done too deep the firſt time, to avoid burying the tender plants; but the laſt earth ſhould be ploughed as deep as poſſible; and the cloſer the mould is thrown to the ſtems of the plants, the more advantageous it will prove. Thus 15 buſhels will plant an acre, and the produce will be about 300 buſhels; but the land, by the ſummer ploughings, will be prepared to receive ſeed-wheat immediately, and almoſt enſure a plentiful crop.

To prevent
the grub.

The potato ſets ſhould be cut a week before planting, with one or two eyes to each, and the pieces not very ſmall; two buſhels of freſh-ſlaked lime ſhould be ſown over the ſurface of the land as ſoon as planted, which will effectually prevent the attacks of the grub.

The expence attending an acre of potatoes well cultivated in the firſt method, ſuppoſing the rent 20 ſhillings, tithe and town charges rather high (as in Suffolk), taking up, and every thing included, will be about 6l. In the laſt method, it would be ſomewhat reduced.

A premium having been offered by the above-mentioned ſociety for the cultivation of potatoes by farmers, &c. whoſe rent does not exceed 40l. per annum, the following methods were communicated, by which thoſe who have only a ſmall ſpot of ground may obtain a plentiful crop.

Methods of cultivating potatoes on ſmall ſpots.

Firſt, then, the earth ſhould be dug 12 inches deep, if the ſoil will allow of it; after this, a hole ſhould be opened about ſix inches deep; horſe dung or long litter ſhould be put therein about three inches thick: this hole ſhould not be more than 12 inches in diameter. Upon this dung or litter a potato ſhould be planted whole, upon which a little more dung ſhould be caſt, and then earth muſt be put thereon. In like manner the whole plot of ground muſt be planted, taking care that each potato be at leaſt 16 inches apart; and when the young ſhoots make their appearance, they ſhould have freſh mould drawn round them with a hoe; and if the tender ſhoots are covered, it will prevent the froſt from injuring them: they ſhould again be earthed when the ſhoots make a ſecond appearance, but not be covered, as in all probability the ſeaſon will then be leſs ſevere. A plentiful ſupply of mould ſhould be given them, and the perſon who performs this buſineſs ſhould never tread upon the plant, or the hillock that

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is raiſed round it; as the lighter the earth is, the more room the potato will have to expand. From a ſingle root thus planted, very near 40 pounds weight of large potatoes were obtained, and from almoſt every other root upon the ſame plot of ground from 15 to 20 pounds weight; and except the ſoil be ſtony or gravelly, 10 pounds or half a peck of potatoes may almoſt always be obtained from each root, by purſuing the foregoing method. But note, cuttings or ſmall ſets will not do for this purpoſe.

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The ſecond method will ſuit the indolent, or thoſe who have not time to dig their ground; and that is, where weeds much abound and have not been cleared in the winter, a trench may be opened in a ſtraight line the whole length of the ground, and about ſix inches deep; in this trench the potatoes ſhould be planted about ten inches apart; cuttings or ſmall potatoes will do for this method. When they are laid in the trench, the weeds that are on the ſurface may be pared off on each ſide about ten inches from it, and be turned upon the plants; another trench ſhould then be dug, and the mould that comes out of it turned carefully on the weeds. It muſt not be forgot, that each trench ſhould be regularly dug, that the potatoes may be throughout the plot 10 or 12 inches from each other. This ſlovenly method will in general raiſe more potatoes than can be produced by digging the ground twice, and dibbling in the plants; and the reaſon is, that the weeds lighten the ſoil, and give the roots room to expand. They ſhould be twice hoed, and earthed up in rows. And here note, that if cut potatoes are to be planted, every cutting ſhould have two eyes, for though fewer ſets will be obtained, there will be a greater certainty planted with potatoes, and a good crop might be expected, as the leaves of trees, thorns, &c. are a good manure, and will ſurpriſingly encourage their growth, and gratify the wiſhes of the planter; who by cultivating ſuch places, will then make the moſt of his ground, and it will be in fine order to receive a crop of corn the the following year.

Beſt method of taking them up.

The ſhorteſt and moſt certain method of taking up potatoes, is to plough once round every row at the diſtance of four inches, removing the earth from the plants, and gathering up with the hand all the potatoes that appear. The diſtance is made four inches, to prevent cutting the roots, which are ſeldom found above that diſtance from the row on each ſide. When the ground is thus cleared by the plough, raiſe the potatoes with a fork having three broad toes or claws; which is better than a ſpade, as it does not cut the potatoes. The potatoes thus laid above ground muſt be gathered with the hand. By this method ſcarce a potato will be left.

Of preſerving them.

As potatoes are a comfortable food for the common people, it is of importance to have them all the year round. For a long time, potatoes in Scotland were confined to the kitchen garden; and after they were planted in the field, it was not imagined at firſt that they could be uſed after the month of December. Of late years, they have been found to anſwer even till the ſucceeding crop has arrived at maturity, which has proved a great ſupport to many a poor family, as they are eaſily cooked, and proverbially require neither kiln nor mill. When taken out of the ground, lay in the corner of a barn a quantity that may ſerve till April, covered from froſt with dry ſtraw preſſed down: bury the remainder in a hole dug in dry ground, mixed with the huſks of dried oats, ſand, or the dry leaves of trees, over which build a ſtack of hay or corn. When the pit is opened for taking out the potatoes, the eyes of what have a tendency to puſh muſt be cut out; and this cargo will ſerve all the month of June. To be ſtill more certain of making the old crop meet the new, the ſetting of a ſmall quantity may be delayed till June, to be taken up at the ordinary time before froſt. This cargo having not arrived to full growth, will not be ſo ready to puſh as what are ſet in April.

If the old crop happen to be exhauſted before the new crop is ready, the interval may be ſupplied by the potatoes of the new crop that lie next the ſurface, to be picked up with the hand; which, far from hurting the crop, will rather improve it.

Mr Young's experiments on the cluſtered potato.

In the Tranſactions of the Society for the encouragement of Arts, a number of experiments are related by Mr Young on that kind called the *cluſtered* or *hog potato*, which he ſtrongly recommends as food for the poor, in preference to the kidney or other more expenſive kinds. The following is the reſult of the moſt remarkable of his experiments.

In the firſt week of March 1780, two acres and a quarter of barley ſtubble were ſown with the cluſter potato, which appeared on the 23d of May. A ſharp froſt on the 7th of June turned them as black as they uſually are by the froſts of November and December. In time, however, they recovered; and by the end of October produced 876 buſhels from the 2¼ acres; which, when cleaned, were reduced to 780, or 350 buſhels per acre; thus affording, when valued only at

6d. per buſhel, a clear profit of 7l. 14s. 4d. per acre. The experiment, however, in his opinion, would have been ſtill more profitable, had it not been for the following circumſtances: 1. The ſoil was not altogether proper. 2. The crop was grievouſly injured by the froſt already mentioned, which, in our author's opinion, retarded the growth for about ſix weeks. 3. The dung was not of his own raiſing, but purchaſed; which cannot but be ſuppoſed to make a great difference, not only on account of the price, but likewiſe of the quality, as happened to be the caſe at preſent. He is of opinion, however, that potatoes, at leaſt this kind of them, are an exhauſting crop. Having ſown the field after this large crop of potatoes with wheat, his neighbours were of opinion that it would be too rank; but ſo far was this from being the caſe, that the wheat ſhowed not the leaſt ſign of luxuriance, nor the leaſt ſuperiority over the parts adjacent which were ſown without dung. He was willing to account for this by the poverty of the dung, and the ſevere cropping which the ground had undergone while in the poſſeſſion of the former tenant. In another experiment, however, in which the ground had been likewiſe exhauſted by ſevere cropping, the ſucceeding crop of wheat ſhowed no luxuriance; ſo that the former ſuſpicion of the exhauſting quality of the cluſter potato was rather confirmed. The ground was a fine turnip loam; but though the produce was even greater than in the former caſe, viz. 356 buſhels from an acre, the profit was much leſs, viz. only 4l. 15s. 6d. An acre of ley ground was ſown at the ſame time with the turnip loam, but the produce from it was only 200 buſhels. Mr Young ſuppoſes that the produce would have been greater if the potatoes had been planted with an iron dibble, as the turf, in ploughing, lay too heavy upon the ſeed. A few rows of other potatoes, planted along with the cluſtered kind, did not vegetate at all; which ſhows that the latter have a more powerful vegetative faculty.

Experiments on a larger ſcale.

Having ſucceeded ſo well with his experiments on this kind of potato hitherto, Mr Young determined to try the culture of them upon a larger ſcale: and therefore, in the year 1782, ſowed 11 acres: but being obliged to commit the care of ſowing them to an ignorant labourer, his unſkilfulneſs, together with the exceſſive cold and moiſture of that ſeaſon, ſo diminiſhed the produce, that he had only a ſingle acre out of the whole. This produced 180 buſhels, which yielded of clear profit 4l. 2s. 6d. From this experiment he draws the following concluſions: 1. "That the poor loam, on which theſe potatoes were ſown, will yield a crop of cluſter-potatoes, though not of any other kind. 2. That the manure for potatoes ought to be carted and ſpread upon all ſoils inclinable to wet before the planting ſeaſon, either in autumn preceding, or elſe during a hard froſt." In 1783 he ſucceeded ſtill worſe; for having that year ſown three acres and a half, the profit did not exceed 11s. 4d. per acre. The produce was about 224 buſhels per acre. He gives two reaſons for the failure of this crop: 1. The cluſtered potato thrives beſt in wet years; but the ſummer of 1783 was dry and hot. 2. The ſpring froſt, by interrupting the hoeing, not only greatly raiſed the expences, but very much injured the crop by encouraging the growth of weeds. Barley was ſown after the laſt crop, and produced well; ſo that our author thinks the potatoes ſeem to be a better preparation for ſpring corn than wheat. His experiment in 1784 produced a clear profit of 2l. 0s. 4d.; the produce being 250 buſhels per acre. Still, however, an error was committed, by employing an old man and woman to cut the ſets, by whoſe unſkilfulneſs there were many great gaps among the potatoes as they came up; ſo that, on the whole he reckons that he thus loſt from 500 to 800 buſhels.

Concluſion favourable to the cultivation of this kind.

On the whole, however, his opinion is favourable to the cluſter potato. "With ſmall crops (ſays he), and at the low rate of value which is produced by conſuming them at home, they are clearly proved to be a crop which will pay the expence of manuring, and very ample tillage and hoeing. This is, after all, the chief object of modern huſbandry; for if a man can rely upon this potato for the winter conſumption of his yard in fattening or keeping hogs, in feeding his horſes, and fattening his bullocks, he has made one of the greateſt acquiſitions that can be deſired; ſince he can do all this on land much too ſtiff and wet for turnips; houſes the crops before the winter rains come on; and conſequently without doing any of that injury to his land which the turnip culture is known to entail, and from which even cabbages are not free. Thoſe who know the importance of winter food on a turnip farm, cannot but admit the magnitude of this object on wet ſoils."

Board of Agriculture's rules of culture.

In conſequence of the threatened ſcarcity in 1795, the Board of Agriculture circulated ſome hints reſpecting the culture of potatoes, which deſerve attention. Concerning the ſorts which ought to be planted, it was obſerved, "1ſt, That the ſorts ſhould not be liable to the *curl*; and, 2d, That they ſhould be mealy. The kind known under the name of the *champion* has thoſe qualities,

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qualities, and is alſo very early and productive. The ox-noble is hardy, keeps well, and in the ſpring boils mealy. The kidney is of an excellent quality; and though the crop is leſs productive, and in ſome ſoils liable to curl, the price at market is proportionably great. The Surinam, cluſter, or yam, ſo well calculated for ſtock, never curls, and is extremely productive. Thoſe who cultivate potatoes on a great ſcale ought to have different ſorts—for early uſe—for keeping—for ſtock."

"The modes of planting are, 1ſt, Drilling on land already in tillage. 2d, Dibbling upon graſs or leys. 3d, Lazy bed on bogs, wet peat moor, and lands too rough to plough.

Drilling.

"*Drilling.*—Soils liable to be wet during the winter ſhould be ploughed in autumn ſo as to lie dry. In the ſpring plough and harrow flat. In April and May the ſets may be planted. Draw furrows three feet aſunder; in thoſe furrows lay the dung, not leſs than twenty loads or tons per acre. Drop the ſets on the manure nine inches aſunder. If the land be at all ſtiff, cover the dung and ſets, by drawing earth over them with hand-hoes; adding more, afterwards, with the plough: if it be light and friable, it may be covered with the plough. Keep the intervals clean by ploughing or horſe-hoeing for ſix or eight weeks after the potatoes appear; afterwards by hand-hoeing. Hand-hoe the rows when young, and afterwards weed them. Take up the crop by opening the rows with a plough, and harrow and pick them more than once.

"Lands prepared and dunged for wheat, that could not be ſown on where the plant has been deſtroyed by the froſt, are ready, without further manuring to receive potatoes in this mode of culture.

Dibbling.

" *Dibbling.*—If the ſoil of the graſs be very rich, it will want no manure: if moderately good, only ten or twelve tons per acre. If no manure be ſpread, plough late in autumn, and ſcuffle or ſkim the ſurface ſhallow; or, for want of thoſe tools, if weeds or graſs ariſe, hand-hoe it in March. If manure be uſed, ſpread it on the ley in ſpring, and plough it in: in either caſe dibble in the ſets ſtraight on the centre of every other furrow, nine inches from plant to plant. Keep clean by hand-hoeing; but a narrow ſkim may be paſſed twice along the intervals. Weed the rows, if neceſſary. When the crop is taken up, plough acroſs the former furrows.

" This method is applicable alſo to dry moors and waſtes capable of being ploughed; and by paring and burning the ſurface during the drying and north-eaſt winds of March dung may be ſaved. To add lime in ſuch caſes, to the aſhes, is beneficial.

" After an early crop of graſs for hay, or after the firſt crop of clover, the land may be ploughed, and potatoes dibbled in, if proper ſets have been preſerved for that purpoſe; and in the more ſouthern parts of the iſland a good crop may be obtained.

Culture by lazy beds.

" *Lazy beds.*—Upon bogs, partially or wholly drained, and upon ſuch rough ſoils as are difficult to plough, this method may be adopted. Pare and burn the ſurface; add lime to the aſhes. Strike the lands into ſtraight beds, ſix feet wide, with intervals of two feet or two and a half. Lay the ſets twelve inches ſquare on the beds, and cover them two or three inches deep, with ſpades from the intervals: when the plants appear, cover them again in the ſame manner one and a half or two inches more. Keep them clean by one hand-hoeing and ſucceſſive weeding. They may be taken up with the plough, by ſplitting the beds, and filling the former intervals, converting the open furrows left of the centre of the former beds, into drains deep enough to leave the land dry in winter.

Produce.

" *Produce.*—In any of theſe methods the farmer may expect from 200 to 300 buſhels an acre, of 75lb. per buſhel; ſome ſoils will yield more, and ſome may afford leſs. The drill method is by much the cheapeſt. If the whole ſhould not be ſaleable, the reſt may be given to fatten oxen, to horſes, and to any other live-ſtock, with advantage; particularly if, when boiled or ſteamed, a handful of ſalt be added to two buſhels of potatoes.

Double crops.

" *Double crops.*—In Cornwall, in Cheſhire, in Lancaſhire, and in the neighbourhood of London, two crops have been obtained from the ſame ground in one year: the mode of raiſing which will be found in the Agricultural Reports from the counties of Cheſhire and Lancaſhire. Thoſe who raiſe early potatoes may certainly have a ſecond crop on the ſame ground.

The ſucceeding crop.

" *The following crop.*—Wheat has been ſown with ſucceſs after potatoes; but barley or oats are more to be recommended. On dry moory ſoils, treated as above, turnips may follow, fed off by ſheep, and theſe by ſpring corn and graſs.

Mode of preſervation.

" *Preſervation.*—The moſt approved method is that of digging in a very dry ſpot, trenches ſix feet wide, and eighteen inches deep; ſpread ſtraw; pile the potatoes into the ſhape of the roof of a houſe; cover tight and cloſe with ſtraw ſix inches thick; and then with earth fifteen to eighteen inches more; flatted regularly and firmly, and ſharp at top; raiſed from three feet to five feet above ground. If there ſhall be any apprehenſion of moiſture, dig a trench a few yards off deeper than that in which the roots are laid. The drier they are, when thus packed up, the ſafer they will be."

Mr Marſhal's remarks

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Mr Marſhal in his Rural Economy of Yorkſhire, has ſeveral very intereſting remarks on the potato. Its varieties, he ſays, are endleſs and tranſitory. The rough-ſkinned Ruſſia potato, which was long a favourite of the Yorkſhire farmers, he is of opinion, has now no longer an exiſtence, more than many others which flouriſhed for a time. "There is ſome reaſon to believe (ſays he) that the diſeaſe which has of late years been fatal to the potato crop in this and in other diſtricts under the name of CURLED TOPS, has ariſen from too long a continuance of declining varieties. Be this as it may, it appears to be an eſtabliſhed opinion here, that *freſh varieties*, raiſed from ſeed, are not liable to that diſeaſe." Our author, however, does not look upon this to be a fact abſolutely eſtabliſhed: though one inſtance fell under his obſervation, in which its removal was in all probability owing to the introduction of new varieties. It made its appearance between 40 and 50 years ago, and ſpread in ſome degree over the whole kingdom. In ſome places it continued but a ſhort time, ſo that its effects are almoſt forgotten. It is ſeldom obvious at the firſt coming up of the plants, but attacks them as they increaſe in ſize; the entire top becoming dwarfiſh and ſhrivelled, as if affected by drought or loaded with inſects: they nevertheleſs live and increaſe, though ſlowly, in ſize; but the roots are unproductive. Some crops have been almoſt wholly

deſtroyed

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deſtroyed by this diſeaſe. In Yorkſhire the Morelands are in a manner free from it, but the Vale is in ſome meaſure infected. Plants procured from the Morelands remain free from it in the Vale the firſt year; but, being continued, become liable to the diſeaſe. Where the attack has been partial, weeding out the diſeaſed plants, as they failed, is ſaid to have had a good effect; and it is ſaid that the Morelanders got rid of the diſeaſe by this means.

Method of raiſing varieties from ſeed.

In Yorkſhire ſome intelligent huſbandmen are acquainted with the method of raiſing potatoes from ſeed; which is as follows: "In autumn, when the apples are beginning to fall ſpontaneouſly, they are gathered by hand, and preſerved among ſand until the ſpring, when they are maſhed among ſand or among freſh mould; ſeparating the ſeeds and mixing them evenly with the mould. As ſoon as the ſpring froſts are judged to be over, they are ſown in fine garden mould; and as faſt as the plants get into rough leaf, and are ſtrong enough to be handled without injury, they are tranſplanted into another bed of rich mould in rows, which are kept clean during ſummer. In autumn, bunches of ſmall potatoes are found at the roots of theſe plants, varying in ſize, the firſt year, from a hazel nut to that of a crab. Theſe being planted next ſpring, produce potatoes of the middle ſize; but they do not arrive at their fulleſt bulk until the third or fourth year. Where the uſe of the ſtove or the garden frame can be had, this proceſs may be ſhortened. The ſeeds being ſown within either of theſe early in the ſpring, the plants will be fit to be planted out as ſoon as the froſts are gone; by which means the ſize of the roots will be much increaſed the firſt year, and will in the ſecond riſe early to perfection."

Another account of the mode of raiſing potatoes from ſeed is given by Mr Henry Doby of Woodſide Chapel, Allerton, near Leeds *. "Take the largeſt potato apples, of the kind you wiſh to renew, and ſtring them on a very ſtrong coarſe thread, and hang them in a dry warm place till the latter end of February; when breaking them very ſmall and waſhing them in ſeveral waters, the ſeed is to be ſeparated from the fleſhy part and ſkins; this done, it ſhould be ſpread on brown paper; and when dry, ſow it in the beginning of March, or ſooner, on a hot-bed, in lines about nine inches aſunder, and one-third of an inch deep, and very thin: water between the lines frequently, and when the plants are riſen a little height, introduce fine rich earth between the lines to ſtrengthen them. They ſhould have air admitted frequently, the better to enable them to bear being removed into the open air as ſoon as the weather ſhall be ſufficiently temperate. Before they are tranſplanted they ſhould be plentifully watered to make them riſe with a large ball at their roots; old rotten horſe-dung and yellow moſs are the beſt manures; plant them in trenches, as celery was formerly, with a ſpace of four feet between the trenches, and 12 or 14 inches between each plant; as they grow up, draw the earth between the trenches to the ſtalks, but do not cover their tops. The ground, when brought to a level, ſhould be dug, and the plants earthed until there are pretty deep trenches formed between the lines. With

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* *Annals of Agriculture*, vol. xix.

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With this treatment they will produce the firſt ſeaſon from a pound weight to five pounds a plant; and many of the plants conſiderably more than a hundred potatoes a-piece; the produce of which for ten or twelve years after will be prodigious."

Dr Anderſon's experiments.

In the 4th volume of the Bath Papers, Dr Anderſon relates ſome experiments made on potatoes raiſed from ſeed. The firſt year they were of different ſizes, from a pigeon's egg to that of a ſmall pea. On planting theſe next year, it was invariably found, that the largeſt potatoes yielded the largeſt crop; and the ſame happened the third, when a few ſhowed bloſſom; but not even theſe had bulbs equal to what would have been produced by very large potatoes. Whence he concludes, that it is impoſſible to aſſign any time in which theſe ſeedling potatoes will arrive at what is called *perfection*; but that it muſt depend very much on the nature of the ſoil and the culture beſtowed on them. From the practice of the Yorkſhire farmers, however, and even from the experiments of the Doctor himſelf, it is evident, that potatoes raiſed in this way will at laſt grow to the uſual ſize, as during the three years in which his experiments were continued they conſtantly increaſed in bulk. Dr Anderſon likewiſe contends, that there is no reaſon for ſuppoſing that potatoes raiſed from bulbs in the ordinary way degenerate, or require to be renewed by ſeminal varieties; and he inſtances the univerſal practice of Britain and Ireland for a great number of years paſt. But this may be accounted for from an obſervation of Mr Marſhal's, that varieties of potatoes, like thoſe of corn, are partial to particular ſoils and ſituations. Hence, by tranſplanting all the different varieties of potatoes into all poſſible ſoils and

Whether potatoes degenerate.

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ſituations, as has been done within this laſt century in the iſlands of Britain and Ireland, theſe varieties have continued for a much longer time than they would otherwiſe have done. In Yorkſhire, Mr Marſhal tells us, that " the old favourite ſorts were driven until ſome of the individual plants barely produced their ſeed again." It is evident, therefore, that there is a neceſſity from time to time of renewing them from ſeed; though it deſerves well to be conſidered whether it would not be more eligible to chooſe the ſeed from a plant in full vigour than from that which is ſo far degenerated that it can ſcarce produce its ſeed. " Potatoes raiſed from ſeed (ſays Mr Marſhal) are a miſcellany of endleſs varieties. Sometimes theſe varieties ar planted miſcellaneouſly; ſometimes particular varietie are ſelected. In ſelecting varieties from ſeedling potatoes, two things are to be attended to; the intrinſi quality of the potato, and its productiveneſs. If theſ two deſirable properties can be found in one plant, th choice is determined. To this ſpecies of attention an induſtry we are indebted for the many valuable kin which have been and now are diſtributed throughou the iſland. It is obſervable, however, that varieties potatoes, like thoſe of corn, are partial to particular ſoi and ſituations. Hence the propriety of huſbandm raiſing potatoes from ſeed; as by this means they o tain, with a degree of moral certainty, a ſort adapted their own particular ſoils and ſituations. Whoever h attended cloſely to the work of taking up potato muſt have obſerved the great inequality in the produ tiveneſs of individual plants. The difference in t produce of adjoining roots, where no diſparity of ſ can influence, will ſometimes be three or four fo

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Hence it is evident, that each variety has its *ſub-varieties*; through whoſe means it can hardly be doubted the parent variety may be improved, and its continuance be prolonged. Thus the farmer has another mean in his power of improving the quality and productiveneſs of his potato crop, by improving varieties; or in other words, ſelecting ſub-varieties, ſuperiorly adapted to his ſoil and ſituation."

How to obtain an early crop.

Sir Archibald Grant, Bart. of Monymuſk, in a letter * to the conductors of the Farmer's Magazine, has recently made known a mode practiſed by him with a view to the ſaving of ſeed, and the obtaining an early crop of potatoes. "In ſpring 1800, (ſays that gentleman), from a ſcarcity of ſeed, I followed a method ſometimes uſed by gardeners, for forcing early potatoes, peaſe and beans, viz. that of planting them out upon a ſmall dunghill, in order to make them come ſooner forward, and afterwards tranſplanting them into the ground. This I did, after they had upon the dunghill riſen to be good plants, and the leaves about an inch long. The dunghill was about three feet broad and 18 inches high, with from 2 to 3 inches of earth upon the top of it, and as long as held about a peck and three quarters of a peck of Aberdeenſhire meaſure (or 32lb. Dutch to the peck) of ſmall potatoes, cut into ſets, ſtuck as cloſe to each other as poſſible in the rows, and each row about two inches aſunder. On the 17th of April, they were put upon the dunghill; on the 2d of May they were in leaf; and on the 14th and 15th of May were planted out into the field; each plant 3 feet aſunder each way. On the 12th June, they were earth-

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* *Farmer's Magazine*, June 1802.

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ed up with the plough, and were afterwards dreſſed in the ordinary method. On the 1ſt Monday of October, being taken up, they produced from 14 to 16 bolls Aberdeen meaſure. In June I obſerved, that potatoes which had been planted in the ordinary way in other parts of the pariſh in the middle of April were ſcarcely appearing above ground when theſe were ſo high as to require being earthed up with the plough; ſo that ſix weeks were gained in growth by this method."

Potatoes planted by ſcooping out the eyes.

During the late great dearth of all kinds of proviſions, a plan was adopted with a view to ſave for food a part of the potatoes uſed as ſeed, which conſiſted of not cutting them into pieces with one or more eyes in each piece, as uſual, but of ſlightly ſcooping out the eyes, which in that ſtate were planted while the greater part of the potato was preſerved for the uſe of man or cattle. This mode of planting potatoes was ſucceſsful with a great number of perſons; but in ſome inſtances, where the ground was not in an excellent ſtate of preparation, the crop is underſtood to have been more defective than when the uſual mode was adopted of cutting off large pieces of the potato along with the eyes. The point, however, about the utility of this mode of practice muſt ſtill be conſidered as doubtful or worthy of farther inveſtigation. We are rather diſpoſed to think that the practice of ſlightly ſcooping out the eye will not ultimately prove beneficial, becauſe in ordinary caſes the plant will be left deſtitute of due nouriſhment from the parent root at too early a period of its growth, and before it is completely capable of deriving its ſubſiſtence from the ſoil around it; in the ſame manner, and for the ſame reaſon, that light ſeed is apt to produce a light crop of grain. This objection may not indeed hold good with regard to potatoes planted on a very fine ſoil, or upon a hot-bed, for tranſplanting after the manner adopted by Sir Archibald Grant above mentioned. But on poor lands, where the ſtrength of the young plants is more ſeverely tried, any defect in the ſize of the root planted will probably always be productive of bad effects.

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2. TURNIP.

Culture of turnip.

Turnip delights in a gravelly ſoil; and there it can be raiſed to the greateſt perfection, and with the leaſt hazard of miſcarrying. At the ſame time, there is no ſoil but will bear turnip when well prepared.

No perſon ever deſerved better of a country, than he who firſt cultivated turnip in the field. No plant is better fitted for the climate of Britain, no plant proſpers better in the coldeſt part of it, and no plant contributes more to fertility. In a word, there has not for two centuries been introduced into Britain a more valuable improvement.

Of all roots, turnip requires the fineſt mould; and to that end, of all harrows froſt is the beſt. In order to give acceſs to froſt, the land ought to be prepared by ribbing after harveſt, as above directed in preparing land for barley. If the field be not ſubject to annuals, it may lie in that ſtate till the end of May; otherwiſe, the weeds muſt be deſtroyed by a braking about the middle of April, and again in May, if weeds ariſe. The firſt week of June, plough the field with a ſhallow furrow. Lime it if requiſite, and harrow the lime into the ſoil. Draw ſingle furrows with intervals of three feet, and lay dung in the furrows. Cover the dung ſufficiently, by going round it with the plough, and forming the three-feet ſpaces into ridges. The dung comes thus to lie below the crown of every ridge.

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Seaſon and method of ſowing.

The ſeaſon of ſowing muſt be regulated by the time intended for feeding. Where intended for feeding in November, December, January, and February, the ſeed ought to be ſown from the firſt to the 20th of June. Where the feeding is intended to be carried on to March, April, and May, the ſeed muſt not be ſown till the end of July. Turnip ſown earlier than above directed, flowers that very ſummer, and runs faſt to ſeed; which renders it in a great meaſure unfit for food. I ſown much latter, it does not apple, and there is n food but from the leaves.

Though by a drill plough the ſeed may be ſown o any thickneſs; the ſafeſt way is to ſow thick. Thin ſowing is liable to many accidents, which are far from being counterbalanced by the expence that is ſaved in thinning. Thick ſowing can bear the ravage of th black fly, and leave a ſufficient crop behind. It is a protection againſt drought, gives the plants a rapid progreſs, and eſtabliſhes them in the ground before it i neceſſary to thin them.

The ſowing turnip broad-caſt is almoſt univerſal i England, and common in Scotland, though improper i ſome reſpects. The eminent advantage of turnip is, tha beſides a profitable crop, it makes a moſt complete fallow and the latter cannot be obtained but by horſe-hoeing Upon that account, the ſowing turnip in rows at three feet diſtance is recommended. Wider rows anſwer n profitable end, ſtraiter rows afford not room for a hor to walk in. When the turnip is about four inches hig annual weeds will appear. Go round every interv with the ſlighteſt furrow poſſible, at the diſtance two inches from each row, moving the earth from th rows towards the middle of the interval. A thin plat

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of iron muſt be fixed on the left ſide of the plough, to prevent the earth from falling back and burying the turnip. Next, let women be employed to weed the rows with their fingers; which is better, and cheaper done, than with the hand-hoe. The hand-hoe, beſide, is apt to diſturb the roots of the turnip that are to ſtand, and to leave them open to drought, by removing the earth from them. The ſtanding turnip are to be at the diſtance of twelve inches from each other: a greater diſtance makes them ſwell too much; a leſs diſtance affords them not ſufficient room. A woman ſoon comes to be expert in finger-weeding. The following hint may be neceſſary to a learner. To ſecure the turnip that is to ſtand, let her cover it with the left hand; and with the right pull up the turnip on both ſides. After thus freeing the ſtanding turnip, ſhe may ſafely uſe both hands. Let the field remain in this ſtate till the appearance of new annuals make a ſecond ploughing neceſſary; which muſt be in the ſame furrow with the former, but a little deeper. As in this ploughing the [illegible] plate is to be removed, part of the looſe earth will fall back on the roots of the plants; the reſt will fill the middle of the interval, and bury every weed. When weeds begin again to appear, then is the time for a third ploughing in an oppoſite direction, which lays the earth to the roots of the plants. This ploughing may be about the middle of Auguſt; after which, weeds riſe very faintly. If they do riſe, another ploughing will clear the ground of them. Weeds that at this time riſe in the row, may be cleared with a hand-hoe, which can do little miſchief among plants diſtant twelve inches from each other. It is certain, however, that it may be done cheaper with the hand.

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hand *. And after the leaves of turnips in a row meet together, the hand is the only inſtrument that can be applied for weeding.

In ſwampy ground, the ſurface of which is beſt reduced by paring and burning, the ſeed may be ſown in rows with intervals of a foot. To ſave time, a drill-plough may be uſed that ſows three or four rows at once. Hand-hoeing is proper for ſuch ground; becauſe the ſoil under the burnt *ſtratum* is commonly full of roots, which digeſt and rot better under ground than when brought to the ſurface by the plough. In the mean time, while theſe are digeſting, the aſhes will ſecure a good crop.

Properties of different ſorts of turnip.

In cultivating turnips to advantage, great care ſhould be taken to procure a good, bright, nimble, and well-dried ſeed, and of the beſt kinds.

The Norfolk farmers generally raiſe the oval white, the large green-topped, and the red or purple-topped kinds, which from long experience they have found to be the moſt profitable.

The roots of the green-topped will grow to a large ſize, and continue good much longer than others. The red or purple-topped will alſo grow large, and continue good to the beginning of February; but the roots become hard and ſtringy ſooner than the former.

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* Children under thirteen may be employed to weed turnips with the fingers. We have ſeen them go on in that work with alacrity; and a ſmall premium will have a good effect. For boys and girls above thirteen, a hand-hoe adapted to their ſize is an excellent inſtrument: it ſtrengthens the arms amazingly. In driving the plough, the legs only are exerciſed; but as the arms are chiefly employed in huſbandry, they ought to be prepared beforehand by gentle exerciſe.

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The green-topped growing more above ground, is in more danger of ſuſtaining injury from ſevere froſts than the red or purple, which are more than half covered by the ſoil; but it is the ſofteſt and ſweeteſt, when grown large, of any kind. We have ſeen them brought to table a foot in diameter, and equally good as garden turnips.

Turnips delight in a light ſoil, conſiſting of ſand and loam mixed; for when the ſoil is rich and heavy, although the crop may be as great in weight, they will be rank, and run to flower earlier in ſpring.

From a ſtatement given by the Agricultural Society of Penzance in Cornwall, it appears, that ſalt is there uſed with great ſucceſs as a manure for turnips. "The extenſive pilchard fiſhery (ſay theſe gentlemen) *, eſtabliſhed on our coaſts fortunately enables us to make ſome uſe of this valuable manure. Salt is frequently imported for curing fiſh at 9d. or 9½d. per buſhel of 84 pounds; and what remains after it has been once or ſometimes twice uſed in preſerving the pilchards, is uſually ſold at [illegible] the ſame price to the neighbouring farmers. Unqueſtionably, ſome animal-oil is united to the ſalt; but in the general opinion this is at leaſt compenſated by the admixture of fiſh ſcales, as that ſalt which has been leaſt uſed is univerſally preferred, and found to be moſt effectual.

"At Michaelmas 1790, Mr Sickler entered on an eſtate ſo much impoveriſhed by the former tenant as ſcarcely to return the ſeed.

"1791.—In the ſpring of this year Mr Sickler prepared

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* *Annals of Agriculture*, vol. xxvii.

pared two acres for turnips which had borne ſeven crops of oats in ſucceſſion. The laſt crop did not produce nine buſhels on an acre.

" In the firſt week of April, the earth from two ditches was carried into the fields and laid in four piles; each pile received three cart-loads of ſea-ſhell ſand, and five buſhels of ſalt. The earth from another ditch chiefly conſiſting of the decayed ſoil which had been taken off the ground in former tillage, was placed in three more piles; and each of theſe received alſo three cart-loads of ſand, but no ſalt, on account of the apparent richneſs of the earth. Half the field was manured with the four firſt piles; but the three laſt not being ſufficient for the other half, what remained was ſown with ſalt at the rate of ten buſhels to an acre.

" The part of the field where ſalt had been uſed, either mixed with earth or alone, produced about half a crop of turnips: but the crop totally failed where there was no ſalt. In the ſpring following, white oats were ſown, and produced a crop of ten buſhels to an acre.

" 1792.—Three acres, which in 1791 had borne a crop of wheat, not exceeding 12 buſhels on an acre, were ploughed before Chriſtmas, and brought into fine tilth by midſummer following. On each acre were ſown 20 buſhels of ſalt, excepting that two ridges towards the middle of the field were purpoſely left without any manure: on theſe two ridges the turnips totally failed, but the remainder of the field produced a plentiful crop.

" 1793.—Four acres of land, completely worn out by ſucceſſive tillages, were ploughed before Chriſtmas; three

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three acres were ſown with ſalt at the rate of 25 buſhels, and the remaining acre with 18 buſhels, without any other manure. The crop was in general a good one, but viſibly beſt where the greateſt quantity of ſalt had been uſed.

“ Crops of turnips have been raiſed with equal ſucceſs by the uſe of ſalt ſince that time, and in the ſevere winter of 1794-95, it was obſerved, that theſe turnips were much leſs injured by the froſt than others ſimilarly ſituated, and cultivated in the common way.

“ When ſalt is uſed in the quantity of 20 or 25 buſhels to an acre, the turnips ſhould not be ſown till at leaſt three weeks after the ſalt. Clover ſown with barley, after turnips raiſed by the uſe of ſalt, has never failed to produce an abundant crop of hay the year following.”

Obſervations with regard to ſeed.

Turnip-ſeed, like that of grain, will not do well without frequent changing. The Norfolk ſeed is ſent to moſt parts of the kingdom, and even to Ireland : but after two years it degenerates ; ſo that thoſe who wiſh to have turnips in perfection ſhould procure it freſh every year from Norwich, and they will find their account in ſo doing. For from its known reputation, many of the London ſeedſmen ſell, under that character, ſeed raiſed in the vicinity of the metropolis, which is much inferior in quality.

When the plants have got five leaves, they ſhould be hoed, and ſet out at leaſt ſix inches apart. A month afterward, or earlier if it be a wet ſeaſon, a ſecond hoeing ſhould take place, and the plants be left at leaſt 14 inches diſtant from each other, eſpecially if intended for feeding cattle ; for where the plants are left thicker, they will be proportionally ſmaller, unleſs the land is very rich indeed.

Method of culture in Norfolk.

Some of the beſt Norfolk farmers ſow turnips in drills three feet aſunder, and at a ſecond hoeing leave them a foot apart in the rows. By this means the trouble and expence of hoeing is much leſſened, and the crop is of equal weight as when ſown in the common method. The intervals may eaſily be cleared of weeds by the horſe-hoe.

Culture of turnip by drill and broad-caſt compared.

There has been laid before the Board of Agriculture*, the reſult of ſome intereſting experiments, which we ſhall here ſtate, that were made by Mr W. Jobſon of Turvelaws, with a view to aſcertain the comparative merits of the two modes of rearing turnips by drill or broad-caſt. The trial was made upon a part of a field of 15 acres ſown in the month of June 1797. "The whole field, ſays Mr Jobſon, was in equal tilth, was manured as equally as poſſible immediately before ſowing with rotted fold-yard dung, at the rate of 17 cart loads per acre, each load containing about 28 Wincheſter buſhels; and in order to make the experiment perfectly fair, there were breadths of [illegible] of 20 yards each, ſown in broad-caſt and drills alternately, throughout the whole field. Part of the drills on one-bout ridges of 27 inches each, with the dung laid immediately underneath, where the row of ſeed was depoſited; the reſt of the drills upon a level ſurface, were ſown by Mr Bailey's machine at 21 inches diſtance. The produce per acre is calculated from the weight of four ſquare perches, or the fortieth part of a

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* *Communications to the Board of Agriculture*, vol. ii.

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a ſtatute acre of each, having firſt cut off the tails, or fibrous part of the root, and thrown them aſide as unfit for food, and then taken the weight of the tops and roots ſeparately.

"It is neceſſary to obſerve, that this field of turnip was but a middling crop, having been much hurt immediately after the firſt hoeing, by the *grub* (a ſmall worm which deſtroys the root), particularly the drilled part of the field, which, having had the plants ſet out, at the diſtances at which they were intended to remain before the grub ſeized them, was on that account rendered too thin and otherwiſe much injured; notwithſtanding which, it was found that thoſe on the one-bout ridges exceeded the others in weight; alſo, that theſe parcels of turnips were taken from an inferior (though not the worſt) part of the field, and may therefore be deemed to be a pretty fair average of the whole: there were alſo three other portions weighed, which were taken from a part of the field where the roots were larger, and a fuller crop, with a view to aſcertain what might have been expected, had not the grub ſeized them in the manner deſcribed; but unfortunately the paper containing their weight has been loſt or miſlaid, which puts it out of my power to furniſh you with it. There was alſo an account taken of the number (but not the weight) of loads which were produced upon a few acres of the worſt part of the field which was in favour of the broad-caſt, in the proportion of ten of broad-caſt to nine of thoſe drills on one-bout ridges, and eight of Mr Bayley's drills.

"From this experiment (though defective from the reaſons aſſigned) we have reaſon to conjecture, though not to form a concluſion, that a heavier crop may be raiſed

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raiſed by ſowing in drills at 27 inches diſtance with the dung immediately beneath the plants, than in broadcaſt or in drills at 21 inches on a level ſurface: but whether the advantage ariſes from the ſituation in which the dung is depoſited, or from their having a freer circulation of air, or from both theſe united, it remains for future and repeated experiments to decide. Notwithſtanding this, it will be found, that each of theſe methods poſſeſſes peculiar advantages and diſadvantages, according to ſituations and circumſtances; the reaſons for which I deduce from the obſervations I have made reſpecting this as well as former crops. In the firſt place, the one-bout ridges I think preferable for early ſowing, and eating off, through the winter months, even ſo late as the month of February, as they are more eaſily procured for food for cattle in deep ſnows; alſo in ſituations where it is difficult to procure a ſufficient number of experienced hoers, thoſe under the drill ſyſtem can be more eaſily managed and at leſs expence, as boys and girls may be readily taught to ſet out the plants with great regularity in very little time; but turnips under this ſyſtem are liable to the inconvenience of being more apt to be injured by ſevere froſts from their high expoſure. Another inconvenience I have alſo obſerved on wet and heavy lands, more eſpecially with little declivity, that although there ſhould, and poſſibly may, be a larger crop produced thereby, yet the land will unavoidably be ſo much poached by carrying them off, that the ſucceeding crop of corn will be leſſened more than the extra value of the turnips will compenſate. When it is attempted to raiſe turnips upon land of this deſcription, it will be found more advantageous to form it into ridges of ſufficient

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height to carry off the water with eaſe into the water furrows, and of ſufficient breadth (ſuppoſe fifteen feet) to allow a cart to paſs along them freely, without forcing the earth in to choke up theſe furrows. The turnips may be ſown either in broad-caſt or in drills, upon the ſurface of theſe ridges. If the land is addicted to annual weeds, they will be beſt in drills, which will expedite the hoeing; but if not, or if they be late in ſowing, or if the land be ſubject to the grub, broad-caſt will generally be found to produce a more certain crop, as they can be left ſo near to each other at the firſt hoeing as to admit of being thinned, and thereby give the opportunity of taking out unhealthy plants at the ſubſequent hoeings, and alſo that they grow more vigorouſly between the firſt and ſecond hoeings."

The reſult of the experiment here alluded to, is ſtated in the following manner:

COMPARATIVE WEIGHT x portions of ps, which were part of a Field of fifteen Acres: the whole of which was S in the Mont une 1797, as an experiment between the Drill and Broad-caſt ſyſtems.

N°	me igh		Weight on four ſquare perches, or the 40th part of an acre.						Weight per ſtatute acre.				Average weight of each turnip.		Average diſtance of each turnip.
			ROOTS.			TOPS.									
			Cwt.	qr.	lb.	Cwt.	qr.	lb.	Tons	cwt.	qr.	lb.	lb.	oz.	
Drilled on one-bout ridges, at 27 inches diſtance.		354	8	1	1	1	1	3	19	1	0	20	3	0¼	16½ in. by 27 in.
Drilled with Mr Bayley's machine, on a level ſurface, at 21 inches diſtance.	dit	428	7	1	15¼	1	1	5¼	17	7	1	8	2	4¼	17 in. by 21 in.
Broad-caſt.	do.	568	7	2	12½	1	0	11¼	17	8	1	26	1	11½	16¾ each way.
Drilled on one-bout ridges, at 27 inches diſtance.	Ma	334	8	3	0	1	1	22	20	7	3	12	3	6½	17 by 27 in.
Broad-caſt. Theſe and the preceding were round white turnips.	do.	628	8	2	22	1	1	8	20	0	2	24	1	12½	16 each way.
Broad-caſt (Red).	do.	561	6	3	26½	2	3	5	19	11	1	0	1	15¾	16½ each way.

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"By noting the average diſtance of each turnip, as is done in the laſt column, is intended to ſhow, at one view, how many plants there were wanting in the drills to have made them a full crop; for, if 550 be ſtated as a medium number in a full crop, upon the 40th part of an acre, they will be found to occupy a ſpace of 17 inches each way in broad-caſt, 10½ by 27 inches on the one-bout ridges, and 13½ by 21 inches of thoſe drilled on the level ſurface; from whence may be eaſily ſeen, how much thoſe were wider in the rows than they ought to have been."

Dr Campbell of Lancaſter, in his eſſay addreſſed to the Board of Agriculture, gives the preference in very decided terms to the cultivation of turnips in drills rather than broad-caſt *. "On comparing the drill with the broad-caſt ſyſtem of cultivating turnips, I feel no heſitation in giving the drill ſyſtem the preference; which opinion is gaining ground faſt among my neighbours, who have had no opportunity of comparing the two methods. To ſay nothing of the ſuperior, neat, and workman-like appearance which a field of drilled turnips exhibits in all its ſtages, there are many circumſtances which contribute to give it a decided ſuperiority over the broad-caſt.

"The firſt is the ſecurity of the crop from the ravages of the fly. When dung is ſpread at random over a field, a part will receive a greater proportion of it than is neceſſary, and another a ſmaller. Should dry and hot weather come on immediately after the ſowing, that dung, which is expoſed to the influence of the ſun,

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* *Communications to the Board of Agriculture*, vol. iii.

will be dried up, and a great part of its juices and the volatile alkali which it contains will be exhaled and loſt. The ſeeds that fall in the intervals betwixt the dung, or where there is a deficiency of it, will languiſh, and perhaps be cut off by the fly or ſnail, and at any rate will never attain a full ſize. In the caſe of the drill method the dung, being buried in the bottom of the furrows, is excluded from all evaporation, and the ſeed being depoſited directly above the dung, is by the warmth which proceeds from it brought into immediate vegetation; and the young roots, as ſoon as the ſeed germinates, ſtriking into the dung, occaſion ſo rapid a growth, that in a few days the plants paſs into the rough leaf, and get beyond the riſk of injury from the fly, ſlug, or whatever vermin have a tendency to prey upon them in their weak ſtate. It would appear, that the weak and ſickly plants are particularly the objects of theſe deſtroyers, rather than the luxuriant and healthy. Vegetables, in a certain ſtate of decay and of a yellow hue, are moſt ſought after, and preyed upon by ſlugs in a garden; and I have taken notice, that ſome turnips from ſeeds accidentally dropt in the intervals of the drills, when there was no manure, have exhibited a ſickly hue, and been preyed upon by ſome inſects, whilſt the vigorous plants in the drills eſcaped. In the courſe of the laſt three years that I have cultivated turnips in ſeaſons where we have experienced the extremes of wet and drought on their coming out of the ground, I have not loſt a ſingle plant by the fly; which I am inclined to attribute to the rapid growth of the plants from the cauſes above enumerated.

" Another advantage ariſes from their being able to ſtir and horſe-hoe the land in the intervals of the drills; by

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by which means the weeds are more early and completely deſtroyed, at the ſame time that the ground is more effectually opened.

"In land abounding with ſtones to the degree of ſome of ours, it appears, that it would be almoſt impracticable to hoe it properly, when ſown in the broadcaſt way: in ſome ſituations it appears almoſt entirely a bed of ſtones, which would render the plants inacceſſible to the hoe; whereas, by the drill method, it is eaſily effected.

"It appears, that in proportion to the deficiency of manure (either in quantity or quality) the drills ſhould be brought cloſer together, and a ſmaller diſtance alſo be left betwixt the plants in hoeing them. It is quite abſurd to leave the ſame ſpace for a turnip, which we know will not attain the bulk of more than a few inches in circumference, as for another that will be two or three feet with the top in the ſame difference of proportion."

Great quantities of turnips are raiſed in Norfolk every year for feeding black cattle, which turn to great advantage.

Value as food for cattle.

It is well known, that an acre of land contains 4840 ſquare yards, or 43,560 ſquare feet. Suppoſe then, that every ſquare foot contains one turnip, and that they weigh only two pounds each on an average; here will be a maſs of food, excellent in kind, of 46 tons per acre, often worth from four to five guineas, and ſometimes more.

Extraordinary crops of barley frequently ſucceed turnips, eſpecially when fed off the land. In feeding them off, the cattle ſhould not be ſuffered to run over too much of the ground at once, for in that caſe they will tread down and ſpoil twice as many as they eat. In Norfolk, they are confined by hurdles to as much as is ſufficient for them for one day. By this mode the crop is eaten clean, the ſoil is equally trodden, which, if light, is of much ſervice, and equally manured by the cattle.

A notion prevails in many places, that mutton fattened with turnips is thereby rendered rank and ill taſted; but this is a vulgar error. The beſt mutton in Norfolk (and few counties have better) is all fed with turnips. It is by rank paſtures and marſhy lands, that rank mutton is produced.

If the land be wet and ſpringy, the beſt method is to draw and carry off your turnips to ſome dry paſture; for the treading of the cattle will not only injure the crop, but render the land ſo ſtiff, that you muſt be at an additional expence in ploughing.

Method of preſerving turnips.

To preſerve turnips for late ſpring feed, the beſt method, and which has been tried with ſucceſs by ſome of the beſt Engliſh farmers, is, To ſtack them up in dry ſtraw; a load of which is ſufficient to preſerve 40 tons of turnips. The method is eaſy, and is as follows:

After drawing your turnips in February, cut off the tops and tap roots (which may be given to ſheep), and let them lie a few days in the field, as no weather will then hurt them.

Then, on a layer of ſtraw next the ground, place a layer of turnips two feet thick; and then another layer of ſtraw, and ſo on alternately, till you have brought the heap to a point. Care muſt be taken to turn up the edges of the layers of ſtraw, to prevent the turnips from rolling out; cover the top well with long ſtraw, and it will ſerve as a thatch for the whole.

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In this method, as the ſtraw imbibes the moiſture exhaled from the roots, all vegetation will be prevented, and the turnips will be nearly as good in May as when firſt drawn from the field. If ſtraw be ſcarce, old haulm or ſtubble will anſwer the ſame purpoſe.

But to prevent this trouble and expence, perhaps farmers in all counties would find it moſt to their intereſt to adopt the method uſed by our neighbours the Norfolk farmers, which is, to continue ſowing turnips to the latter end of Auguſt; by which means their late crops remain good in the field till the latter end of April, and often till the middle of May.

The advantages of having turnips good till the ſpring feed is generally ready, are ſo obvious, and ſo great, that many of the moſt intelligent farmers (although at firſt prejudiced againſt the practice) are now come into it, and find their account in ſo doing.

Their culture ſaid to be generally attended with no profit.

Turnips have long been in ſuch general uſe as food for cattle, that the profit on raiſing them might be reaſonably thought to be altogether certain; nevertheleſs, Mr Young, in the paper already quoted, informs us, that "turnips dunged for are univerſally a loſing crop; for if they are ſtated from 30s. to 40s. an acre, their value does not amount to the dung alone which is ſpread for potatoes; yet the latter pays that dung, all other expences, and leaves a profit ſometimes conſiderable. I admit that turnips fed upon the land will prepare better for corn; but that is by no means the queſtion. Would not the dung raiſed in the farm-yard by the conſumption of the potatoes, ſuppoſing it ſpread on the potato acre, make that produce more than the turnip one? I have no doubt but it would give a ſuperiority. But turnips are liable to great failures, Compared with other vegetables as food for cattle.

and cannot be relied on late in the ſpring: potatoes may; and are applicable to uſes to which the other root cannot be applied."—In the ſecond volume of the Bath Papers, p. 101. we have a comparative account of the value of turnips, turnip-rooted cabbage, and lucerne, as food for cattle. The reſult of this writer's obſervations is, that "when ſheep are allowed as many turnips as they can eat (which ſhould always be the caſe when they are fattening), they will, on an average, eat near 20 pounds each in 24 hours. An acre of turnips twice hoed, will, if the land be good, produce about 50 tons; which will, on the above calculation, maintain 100 ſheep 52 days. The ſheep mentioned weigh 20 pounds per quarter. An acre of turnip-rooted cabbage will maintain 100 ſheep for a month, and ſometimes five weeks; but an acre of Scots cabbages will maintain 200 ſheep a full month." The number fed by lucerne is not determined.

The fly occaſions the great inconvenience in turnip culture.

The greateſt diſadvantage which attends a crop of turnips, is their being ſo ready to be damaged by the fly, which ſometimes deſtroys them ſo completely, that they muſt be ſown over again two or three times the ſame ſeaſon, and even this without any certainty of ſucceſs. Innumerable methods of avoiding this evil have been projected, ſeveral of which were formerly noticed; and we ſhall here introduce ſome additional remarks upon the ſubject. We have already ſtated Dr Campbell of Lancaſter's propoſal to drill with dung under the rows. The remaining remedies may all be reduced to the following claſſes: 1. Steeping the ſeed in certain liquids. 2. Fumigation of the fields with the ſmoke of certain herbs. 3. Rolling. 4. Strewing ſoot, lime aſhes, &c. on the ſurface of the ground. It is very difficult, however,

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however, to determine, with any degree of certainty, whether remedies of this kind are effectual or not; becauſe ſometimes the turnips are not injured though no precaution has been made uſe of: and when this happens to be the caſe, after the uſe of any ſuppoſed preventive, the preſervation of the crop is aſcribed to the uſe of that preventive, whether it be really efficacious or not. The virtues of ſteeps ſeem to have been fully aſcertained by Mr Winter Charlton near Briſtol, of whoſe experiments an account is given in the Tranſactions of the Society for Encouraging Arts, vol. v. The ſeeds were of the Dutch kind, ſowed on beds in the kitchen garden in drills, about twelve inches diſtant, an inch and a half deep, on the 11th of May 1786. The beds had been prepared with rotten dung in May 1785, and afterwards ſown with cabbages. The quality of the turnips is exhibited in the following table; the beſt being marked 1; and thoſe of inferior quality, 2, 3, &c. The obſervations were taken on the 26th of June.

Whether ſteeps for turnip ſeed be of any uſe.

Seed without any preparation, - -	1
ſteeped in train oil, flouriſhed extremely.	
ſteeped in linſeed oil, ſomewhat inferior,	1
Seed mixed with ſoot and water, - -	2
with drainings of a dunghill, -	2
with elder and barton draining, -	2
with ſoot, - - -	3
with elder-leaf juice, - -	3
with elder and barton draining, ſoot being ſowed over the covered drills,	3
with ditto, and lime ſowed over the drills, - - -	3
ſowed with ſoot ſcattered over, and then covered, - - -	3

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Seed ſowed with barton draining, - - 4
an elder buſh drawn over when the plants appeared, - - 4
with ſtale human urine, very few plants appeared.
with ſlaked lime ſcattered over, and then covered, very few plants appeared,
with elder, barton-draining, and ſlaked lime, very ſew plants appeared,
with lime and barton-draining did not vegetate.

Another ſet of experiments was made with the green Norfolk turnip, drilled an inch and a half deep, the rows one foot diſtant, on beds eight feet three inches long, and two feet wide; half a drachm of ſeed allowed for each bed, ſteeped and mixed with various ſubſtances like the former. The ſeeds were drilled upon unmanured ground on the 20th of June 1786, and the obſervation made on the 17th of July. None of the beds were found free from the ravages of the fly; but the ſeeds which had been ſteeped in train oil and linſeed oil were much more free from this injury than the others. The linſeed oil, as in the former experiment, was found inferior to the train oil, which was ſuppoſed to have been owing to its being kept in a bottle that had formerly held oil of turpentine. The leaves of the ſteeped ſeeds were of a much darker green than the others, appeared twice as thick in bulk and luxuriancy, and the plants were conſiderably larger than thoſe of the other kinds. The ſubſtances mixed with the reſt were ſoapers aſhes, wood aſhes, pounded gunpowder, brimſtone, ſlaked lime, ſoot, barton-draining; ſometimes mixed together in various proportions, and ſometimes with the addition of a portion of ſifted mould.

Mr Gullet's directions for fumigation.

Theſe experiments ſhow, that no dependence can be had on ſteeps or mixtures of any kind with the turnip-ſeed; though the train oil and linſeed oil ſeem greatly to have forwarded the vegetation of the plant. It does not appear that fumigation has ever been tried; nor indeed does it ſeem eaſy to be tried in ſuch a manner as might enſure ſucceſs.—In the fourth volume of the Bath Papers, Mr Gullet of Devonſhire gives ſuch directions for performing the operation as he thinks would be productive of ſucceſs.—In a preceding paper he had explained the good effects of fumigating orchards; but the caſe with theſe muſt be very conſiderably different from a field of turnips. The trees in an orchard are elevated above the ground, and the ſmoke naturally aſcends, and is blown along their tops: but in fumigating a large field of turnips, it muſt creep along the ground in ſuch a manner as is by no means agreeable to its nature; and without any exceſſive degree of labour, as well as a vaſt quantity of burning materials, there cannot be the leaſt hope of ſucceſs. Mr Gullet's directions are as follow: « If the turnip-ground be ſpaded and burnt, or the weeds, &c. burnt without ſpading, the fumigation thereby may ſuffice to chaſe ſuch of the winged tribe from thence as are then there; but in all caſes, when the field is ploughed and ready for ſowing, let heaps be made at different places and intervals round by the hedges and boundaries of the turnip-ground, and ſome few ſcattered through the field; then, as ſoon as the ſeed is ſown, let the heaps on the windward ſide and the ſcattered ones be lighted and kept ſmothering during

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ring the continuance of the wind in that quarter; the leſs the fire, and the more the ſmoke, the better. Should the wind happen to ſhift, thoſe heaps on the quarter it ſhifts to muſt then be lighted and kept ſmothering in like manner; ſo that during the growth of the tender turnip leaf, and until it becomes rough and out of all danger, this fumigation and ſmoke, over and acroſs the field, muſt be continued from one quarter to the other; which I venture to aſſert, will effectually deter and prevent any winged inſect tribe from approaching the turnip-ground: nay more, if there already, it would moſt completely drive them from thence, as ſuch delicately formed inſects (which can only feed on the moſt tender leaf) would be ill able to continue long in ſuch a ſmother of fire and ſmoke. The conſequence is obvious and certain, that if the fly be kept from approaching the field, the turnip-crop is ſafe; and few, I believe, will diſagree with me, that *prevention is better than remedy*."

Our author does not ſay that he has ever tried this method with turnips; but lays great ſtreſs upon his ſucceſs in a ſimilar experiment with cabbages, in order to preſerve them from the caterpillar. To make the matter more ſure, however, he recommends the trailing of a buſh of elder over the turnip field at the time of harrowing or bruſhing in the ſeed: but this remedy has by numberleſs experiments been found inſignificant, and by thoſe above related ſeems even to be pernicious: ſo that whatever good effects we can expect from this method, muſt depend on the fumigation alone; and even this is attended with very great uncertainties, as has already been obſerved.

Of rolling.

Rolling promiſes to be of ſervice when the young turnips are attacked by ſnails, which frequently deſtroy them; but it cannot be ſuppoſed to have much effect in deſtroying flies, theſe being too numerous and too minute to be effectually cruſhed by the roller: and indeed, though this has been frequently recommended, we have no deciſive proofs of its having ever been attended with any good effect.

The ſtrewing of ſoot, lime, aſhes, &c. upon the ground, have been determined ineffectual by the experiments already related, at leaſt when applied before the turnips come up; and there ſeems to be little hope of their proving more effectual even when applied after the crop has appeared above ground. We may argue indeed *à priori* about the taſte or ſmell of ſoot, lime, &c. being diſagreeable to inſects; but of this, after all, we have no ſufficient proof; and even though this were the caſe, the leaf ſoon emerges from under this covering, or the inſects will feed on the under part of the leaves, where theſe ſubſtances cannot lie. It is evident, therefore, that very little can be expected from any of the methods hitherto propoſed either by way of cure or prevention. The more probable methods are,

Early ſowing recommended.

1. To ſow the turnips at ſuch a ſeaſon of the year that they may be well grown before the fly makes its appearance. In the Bath Papers, vol. iv. p. 132. Mr Wimpey obſerves, that in order to procure food for their cattle in the ſpring before the graſs is grown, farmers are obliged to poſtpone the ſowing of turnips beyond the natural time of vegetation: but were turnips to be ſown in April, as ſoon as the ſeaſon would permit, it is very probable that there would be as great a crop of them as of other vegetables uſually ſown in theſe months. On account of the delay in ſowing, however,

for the reaſon already mentioned, the ſucceſs of the farmer becomes exceedingly precarious, unleſs he is ſo fortunate as to have a few rainy days, or cloudy weather and frequent ſhowers, ſoon after the ſeed is ſown: and this our author ſuppoſes to be the true reaſon why the turnip is a more uncertain article than any other. But though ſpeculations of this kind have a great ſhow of probability, there is not any experiment hitherto publiſhed, even by our author himſelf, by which the truth of the above conjecture can be abſolutely aſcertained. Our author, however, is of opinion, that none of the common methods propoſed can anſwer any good purpoſe, farther than as by means of them the vegetation of the plant may be invigorated. Mr Wimpey recommends aſhes, ſoot, or a rich compoſt of lime and dung, uſed in ſufficient quantities; but the method of uſing them is, either to ſow them with the ſeed, or rather by themſelves immediately before, and to harrow them well in, that they may be completely incorporated with the ſoil. This for the moſt part would ſo invigorate and encourage the growth of the plants, as to be an overmatch for the moſt vigorous attacks of the fly.

Sowing a great quantity of ſeed.

2. Another method propoſed for ſecuring turnips from the fly, is by ſowing ſuch a quantity of ſeed as will be more than ſufficient for the conſumpt of the inſects. This we find recommended in a letter to the Bath Society, by a gentleman-farmer in Eſſex, vol. ii. p. 238. His method is to make the land clean and fine as ſoon as the ſeaſon will permit, and to ſow four pints per acre. It may be objected, that if the fly does not take them, the plants will ſtand ſo thick, that they cannot eaſily be hoed; but this may be obviated by harrowing them firſt, which will make them fit for the

hoe. There can be no expectation of a crop if the fly takes them when only a pint of ſeed is ſown per acre; but this gentleman remarks, that he has not in any one inſtance miſſed of a crop when he ſowed four pints; becauſe, though the fly has ſometimes deſtroyed more than one half, and much damaged the othe , ſtill there was a ſufficient number left behind. He alſo agrees with others of the Society's correſpondents, that the ground ſhould be well dunged and manured previous to the ſowing of turnips, as this makes them grow vigorouſly, ſo that they quickly get into the rough leaf, in which ſtate the fly will not touch them.

Manuring in autumn preferable to ſpring manure

In the ſame volume, a gentleman of Norfolk remarks, that manuring the ground in autumn for turnips is preferable to the doing ſo in ſpring. This diſcovery he made in conſequence of the following accident.—"A neighbouring farmer, not having a ſufficient quantity of manure for all his turnip land, was under the neceſſity of ſowing four acres unmanured. The effect was, that the turnips on the manured part of the land were moſtly eaten off by the fly, while four acres unmanured eſcaped without injury." In conſequence of having obſerved this, the gentleman made a ſimilar experiment, by manuring five acres well for turnips, and tilling three acres and a half in the uſual way without any manure. The manured crops were almoſt all deſtroyed by the fly, ſo that he was obliged to ſow moſt of the land over again. The three acres and a half which had no manure were entirely free from injury, though the plants were much ſmaller than thoſe of the manured ground which came up. Not content with this trial, however, he repeated the experiment, by manuring ſix acres of wheat ſtubble in autumn, ploughing it in

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in immediately, and leaving it to incorporate with the earth during the winter: the turnips which grew upon this were as large as if the ground had been manured in the ſpring. This experiment was repeated with ſurpriſing ſucceſs in two ſucceeding years; whence he infers, that the fly is either engendered in the new dung or enticed by it. But when the manure is laid on in autumn it loſes its noxious qualities, though it ſtill retains its nutritive ones.—This concluſion, however, does not appear to be well founded; for it is certain from undoubted experience, that turnips which have been well manured in the common way, have ſometimes eſcaped any injury; while others, which have got no manure at all, have been almoſt totally deſtroyed. Another material advantage, however, which this correſpondent obſerves is to be derived from manuring in autumn is, that all the ſeeds contained in the manure, and which are of courſe carried to the land with it, vegetate almoſt immediately, and are moſtly killed by the cold of the ſucceeding winter, while the few that remain can ſcarce eſcape deſtruction from the ploughſhare.

Mr Wimpey's opinion of ſowing a great quantity of ſeed.

Mr Wimpey is alſo of opinion, that it is proper to ſow a large quantity of ſeed; but thinks two pounds will be ſufficient for an acre. A few ounces indeed would be ſufficient to ſtock the land; but as the article is ſo precarious, he thinks it by far the ſafeſt way to allow ſeed in plenty, and reduce the plants afterwards by harrowing. He obſerves alſo, that it is of great conſequence to have ſeed both good in quality and of the beſt ſpecies. He prefers the large and green topped, as being the moſt ſweet and juicy; others give the preference to the red or purple-topped, as being hardier:

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hardier: but at any rate, the ſeed from the largeſt and fineſt tranſplanted turnips, of whatever ſort, is greatly to be preferred, even though it ſhould coſt double or treble the price. Such as is ſold by the ſeedſmen in London he found generally of a mixed kind, and often in great part not worth cultivating. "Whether plants from new or old ſeed are moſt ſecure from the depredations of the fly (ſays he), is perhaps a queſtion which cannot be eaſily determined even by experiments; for concomitant circumſtances are frequently ſo much more operative and powerful, as to render the difference between them, if there be any, imperceptible. It is, however, known to every practical man, that new ſeed ſprouts or vegetates ſeveral days before old; and I think more vigorouſly: and it is equally well known, that the healthy and vigorous plants eſcape the fly, when the ſtinted and ſickly ſeldom or never eſcape it. Hence it would ſeem, that new ſeed, *cæteris paribus*, is more ſecure from the fly than old; and for my own uſe I would always prefer it."

Of the quality of the ſeed.

3. The ſowing of turnips along with grain.—This, of all others, ſeems to be the moſt eligible and efficacious. In the ſecond volume of Bath Papers. p. 210. a Hertfordſhire correſpondent gives an account of the ſucceſs of an experiment of drilling turnips with wheat. A ſmall field of ſpring-wheat was drilled in rows two feet apart; and in the month of May turnips were ſown by hand in the intervals. They came up very well, and were thinned once by the hoe. The crop of wheat turned out better than another field of the ſame ſoil ſown broad-caſt in autumn, though it ripened ſomewhat later. The turnips were no other way injured by cutting it, than having ſome

Of ſowing turnips with grain.

With wheat.

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of the large leaves trodden down by the reapers. After harveſt the weeds were cut up round the turnips with a hand-hoe, and they grew very large and vigorous. They were of the purple and white long kind, and the crop proved nearly as good as the ſame land produced in common. An excellent crop of barley and clover was got from the ſame field afterwards.

Mr Anderdon's experiments of ſowing them with beans.

In the third volume of the ſame work we find an account of ſeveral ſucceſsful experiments in ſowing turnips between rows of beans. The advantages of this method are ſtrongly ſet forth by R. P. Anderdon, Eſq; who made ſome of the experiments, and are as follow: "1. You may have a crop of beans and turnips on the ſame field the ſame year. 2. The bean crop being well horſe-hoed, no ploughing is wanted for turnips. for which the beſt Norfolk farmers give five ploughings. 3. It is hoed cheaper, more effectually, and conſequently more profitably, than in any other way. 4. The ground is kept clean from weeds. 5. It is in order for a Lent crop the ſucceeding year with one earth. 6. The ground is kept in heart, if not improved, by fallowing your alleys. 7. It brings the plant to perfection in poor ground, where it would not become ſo otherwiſe. 8. It doubles the crop in any ground which Mr Anderdon has had experience of. 9. You have the crops more within your own power in this than in any other method, let the ſeaſons turn out as they will. 10. You may have on the ſame ground a bean and turnip crop annually, if the land be ſuitable, and you think proper. 11. The clay farmer, by this mode, renders land which is naturally unfit for turnips, ſo free and open by ſeaſonable horſe-hoeings, that it will bring this uſeful plant to great perfection."

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Objections by the Bath Society.

On this paper the Society made ſome remarks, and ſtated the following objections: 1. The ſame ſoil cannot be proper for both crops. Scotch cabbages are more adapted for a bean ſoil; and they wiſhed him to repeat the experiment with cabbages inſtead of turnips betwixt his beans. 2. The Norfolk farmers rarely uſe more than three ploughings for turnips, inſtead of five, as Mr Anderdon repreſents, unleſs the ground be full of couch-graſs. 3. They think him too ſanguine in his expectations of having double crops on the ſame field. 4. Nothing renders a clay ſoil ſo free and open as to have it expoſed to froſts and ſnow by being laid up in high ridges in January and February; but, on Mr Anderdon's plan, this cannot be done, unleſs the turnips are leſſened in value by being fed off in autumn.

Theſe ſtrictures were ſent to Mr Anderdon before the papers were printed, but did not make any alteration in his opinion; and he replied to the following purpoſe:

Mr Anderdon's reply.

1. *The ſame ſoil cannot be proper for beans and turnips,* &c.—Granted.—But had Mr Anderdon adhered rigorouſly to this rule, he would have ſowed no turnips at all, not having on his farm any ſoil altogether proper for that crop; "but (ſays he) while I can get in ſingle rows, four feet aſunder or more, from half a dozen to half a ſcore tons of turnips per acre, after, or rather between, a crop of beans in my heavy lands, I ſhall feel that product here more beneficial than to drop the mode."

Mr Anderdon then proceeds to acquaint the committee, that he had tried the experiment as they wiſhed with Scotch cabbages inſtead of turnips betwixt the rows of beans; but the crop of the turnips was ſo much preferable, that he found himſelf inclined to ſuppoſe the cabbage would not get to ſo great perfection there as to be profitably introduced on a large ſcale, for want of the great quantity of dung neceſſary for that crop, and which could not be procured in that part of the country. He further remarks in favour of turnips, that they have an abundance of very ſmall lateral fibrous roots, which run as far in ſearch of food, and feed as ravenouſly where they can penetrate, as thoſe of almoſt any other vegetable; and the plant certainly derives more nouriſhment from thoſe than from its tap-root*.

2. *The Committee doubt of the poſſibility of doubling the crop.* Mr Anderdon gives the following explanation: "I have made many comparative trials on turnips between this mode and broad-caſt ſowing, and always found on *my ground* the horſe-hoed crops the beſt. But here, in denoting the benefits of the horſe-hoe by its *doubling* a crop, I wiſh to be underſtood, that if, *in ſoils like mine*, a crop be drilled, leaving proper intervals for horſe-hoeing, and one part be horſe-hoed, the other not, the horſe-hoed part will double the other in product."

Mr Pavier's opinion.

This ſubject is further conſidered in the ſame volume by Mr Pavier, who viewed Mr Anderdon's turnips, and gave in a report of them to the committee. He ſuppoſes a crop of beans drilled in ſingle rows at four feet diſtance, and the turnips drilled in the intervals,

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* Here the Society remarks, that this is not the caſe with thoſe kinds of turnips which grow chiefly above ground, and which are generally the beſt crops, and moſt capable of reſiſting the froſts.

vals, according to Mr Anderdon's method, there will then be four rows of 17 feet in length to make a ſquare perch; whereas Mr Anderdon's rows were only 15 feet 8 inches in length; and this diſparity in length will make a difference of weight on a perch from 230 to 249 pounds, and on an acre from 16 tons 8 cwt. 2 qrs. 8lb. Mr Anderdon's produce, to 17 tons 15 cwt. 2qrs. 24lb.—Each turnip at this diſtance (viz. four feet from row to row, and nine inches in the rows) muſt occupy a ſpace of three ſquare feet; conſequently the greateſt number produced on an acre muſt be 14,520; but if ſown in broad-caſt, twice hoed, and the diſtance on an average 15 inches, each turnip will then occupy little more than one foot and an half, and the number produced on an acre may be about 27,920; an exceſs which may reaſonably be ſuppoſed to overbalance the value of the beans, let us ſuppoſe the crop as great as we can reaſonably do. Thus far the argument ſeems to lie againſt this method of cultivating beans and turnips together: but, on the other hand, Mr Pavier conſiders it probable that the expence of drilling and horſe-hoeing the beans, together with drilling the turnips in the manner Mr Anderdon did, muſt be conſiderably leſs than that of fallowing and preparing the ground, and ſowing the turnips in broad-caſt; to which we muſt likewiſe add the facility of hoeing the drills in compariſon of the broad-caſt. But beſides theſe, the great advantage ariſing from this method, and which, if certain, gives it a decided ſuperiority, is, "the great chance, if not an almoſt certainty, of preſerving the turnips from the depredations of the fly." Mr Pavier was inclined to think that this muſt be the caſe, as Mr Anderdon had ſuch crops repeatedly with-

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out any damage of that kind: but the committee differ from him, and think that this muſt have proceeded from ſome other cauſe; though they do not aſſign any reaſon for this opinion. "The principal point (ſays Mr Pavier), in determining this queſtion, ſeems to me to be this: if the crop of beans drilled as above after deducting the ſeed, and ſome additional expence in taking the crop off the ground without injuring the turnips, can be, one year with another, ſuppoſed to be as valuable as the quantity of turnips that might be reaſonably expected in the broad-caſt method more than in the other, I ſhould not heſitate to declare in favour of drilling between the beans."

Thus far the argument ſeems to be carried on *a priori*. Mr Wimpey, in the letter already quoted inclines to the practice of ſowing turnips between beans planted in rows. "It exactly correſponds (ſays he) with all my obſervations on the ſucceſsful vegetation of that root. A conſiderable degree of moiſture is neceſſary to the rapid vegetation of that very juicy root, and nothing retains moiſture equal to ſhade: and ſhade can be obtained and ſecured by no means ſo effectually on a large ſcale as in the intervals of tall growing plants, as beans or wheat planted in drills." The ſucceſs of Mr Bult of Kingſton, near Taunton, leaves little room to doubt of the propriety of the method, and its ſucceſs in preventing the fly. The beans were planted in drills not quite two feet aſunder, on two ploughings, horſe-hoed three times, and the turnips ſown in the intervals at the laſt-hoeing. The field meaſured ſix acres and a quarter, and was a very good clayey ſoil, but had not been manured, nor had any dreſſing laid upon it, for ſix years before. It produced this year three quarters of beans per acre, and 37 tons 5 cwt. of turnips. This field was alſo viewed by Mr Pavier, who makes the following obſervations upon it. 1. The turnips were ſown promiſcuouſly among the beans at the laſt hoeing, which was given about midſummer; from which time nothing was done but drawing off the beans and carrying them off the land. 2. The crop of beans was believed to be conſiderably above 20 buſhels per acre, which is much more than was produced by any other method that ſeaſon in the neighbouring part of the country; and as Mr Pavier had this account before he ſaw the turnip crop, he did not expect any thing conſiderable from the latter; but as it turned out, the produce muſt be accounted highly profitable, when we conſider that there was no crop loſt, no preparation, dreſſing, nor any expence whatever, excepting the price of the ſeed and ſowing it. 3. This he conſiders as one of the ſtrongeſt recommendations of the drill huſbandry he ever knew or heard of; but he is of opinion that it never can anſwer except where the ground is perfectly clean and free from weeds, by the crops having been horſe-hoed for a few years before. 4. He thinks the beans ought to have been planted at wider intervals, by which the ſun and air would be freely admitted, and the plants would alſo be leſs damaged by the operation of the hoe.

Other experiments on ſowing turnips among beans.

Mr Pavier likewiſe informs the Society of two other experiments on a ſimilar plan; but with this difference, that the turnips were ſown among the beans at the ſecond horſe-hoeing. The turnip crops were very good, and the beans more than *double* the value of thoſe raiſed in the uſual mode of huſbandry. "I think it is

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very evident (ſays he), that the beans preſerve the turnips from the fly; and as no expence or trouble attends the practice, I apprehend it will ſoon become more general." The Society own, that the uncommon ſucceſs of Mr Bult's experiment *ſeems to militate* at leaſt againſt what they ſaid on Mr Anderdon's letter; but they inſiſt that the caſes are by no means ſimilar. "Though the land (ſay they), in both inſtances, is called a *heavy clay*, they are very different. Mr Anderdon's is poor, wet, and cold: the other a good rich clay; and we apprehend naturally mixed with a kind of marl, which is called clay by perſons not thoroughly acquainted with the nice diſtinction of ſoils apparently alike, but very different in their nature. Our principle therefore, that cold wet clay lands are unſuitable for turnips, remains unaffected by this experiment; and general practice confirms the truth of the theory."

In another letter, Mr Pavier gives a more particular account of the two other crops of beans and turnips raiſed upon Mr Bult's plan. The beans were drilled in rows about 22 inches diſtance, twice horſe-hoed, and the produce from about 25 to 30 buſhels the computed acre, or from 30 to 36 buſhels the ſtatute acre. The preceding ſummer had been very unfavourable to beans, and the produce per acre in the common huſbandry did not, on an average, equal a third part of this quantity. One of theſe crops was ſuperior to that of Mr Bult: they were ſown upon a field of nine computed acres on the 10th of June, after the ſecond horſe-hoeing; but whether the ſecond hoeing was performed too ſoon, the ground not clean, or whatever might be the cauſe, the beans were weeded twice by hand afterwards; and he is of opinion, that the turnips were ſomewhat benefited by it. Mr Pavier was aſſured by a very intelligent farmer, that this was the beſt crop of turnips he had ever ſeen. The turnip-ſeed in the other [illegible] was put in between the rows of beans by a hand drill; but the work was badly performed, the plants coming up in ſome places vaſtly too thick, and in others as much too thin; but wherever they happened to be of a proper thickneſs, the farmer told him it was one of the moſt profitable crops he ever had. The ſoil was wet, heavy, and not very ſavourable for turnips. Hence Mr Pavier deduces the following concluſions: 1. That with reſpect to beans in particular, the drilling and horſe-hoeing is vaſtly ſuperior to the common mode of huſbandry. 2. That the beans are undoubtedly a good preſervative of the turnips from the depredations of the fly. 3. That as by this method no crop is loſt, and conſequently no rent, but a mere trifle of expence (if any) chargeable to the turnip crop, it muſt be one of the moſt profitable as well as the moſt certain methods of propagating that uſeful root ever yet practiſed.—He ſtill inſiſts, however, that if he had an opportunity of trying this method, he would drill the beans in rows at a greater diſtance, that the turnips might be hand-hoed eaſily; and that he ſhould prefer the London tick-bean to any other, by reaſon of their ſhortneſs and being ſuch bearers; that he ſhould alſo take off their tops as ſoon as the under bloſſoms began to decay; which, he ſuppoſes, would be of great ſervice.

Inſtrument for tranſplanting turnips.

In this diſſertation on the culture of turnips, we cannot avoid taking notice of an inſtrument uſed in Norfolk for tranſplanting them, and thus filling up the gaps which frequently happen in fields from the failure

of

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of the plants in particular ſpots *. It is repreſented in Plate XIII. fig. 4. and the conſtruction and mode of uſing are obvious from the figure.—When the turnips are to be tranſplanted, the workman holds the long handle with the left hand, and the ſhort one with the right hand drawn up. Put the inſtrument then over the plant that is to be taken up, and with your foot force it into the ground; then give it a twiſt round, and by drawing it gently up, the earth will adhere to the roots of the plant in a ſolid body; then with another inſtrument of the ſame ſize take the earth out where the plant is to be put, and bringing the inſtrument, with the plant in it, put it into the hole which has been made by the other; then keep your right hand ſteady, and draw up your left, and the earth and plant will be left in the hole with the roots undiſturbed. In this operation two men muſt be employed, each of them having an inſtrument of the form repreſented in the plate. One man takes up a plant, while the other fills his inſtrument with earth only, thereby making room for the depoſition of the plant; ſo that the hole which is made by taking up the plant is filled with the earth taken out where the plant is to be put; which being depoſited, he takes up a plant, and returns to the place he firſt ſet out from, the former man at the ſame time returning with the earth only; ſo that each man is alternately the planter, and each being employed both ways, the work goes on briſkly.—This inſtrument was the invention of Mr Cubitt Gray of Southrepps, Norfolk.

Turnips

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* *Bath Papers*, vol. iv. p. 126.

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Norfolk cultivation of turnips.

Turnips being the grand baſis of the Norfolk huſbandry, Mr Marſhal gives a very particular account of their culture in that county.—The ſpecies cultivated are, 1. The common *white-ſtock*, called in many places the Norfolk turnip. 2. The *purple-ſtock* is ſimilar to the former, but its rind is of a dark red or purple colour; its ſize in general ſmaller and its texture cloſer and firmer than that of the common white-ſtock; it alſo ſtands the winter better, and is more ſucculent in the ſpring, but it is not ſo well reliſhed by cattle as the former; whence it is leſs generally cultivated. 3. The *pudding-ſtock*, the *tankard-turnip* of the midland counties, is in ſhape ſo perfectly different from the common ſort, that it might be ranked as a diſtinct ſpecies. It riſes in a cylindrical form, eight, ten, or twelve inches high, ſtanding in a manner wholly above ground; generally taking a rough irregular outline, and a ſomewhat reclining poſture. It very much reſembles the common turnip, and is by much its moſt formidable rival. In many reſpects it ſeems to be ſuperior, particularly in being readily drawn, and eaten off by ſheep with much leſs waſte than the common turnip.—The diſadvantage is, that they are liable to the attacks of froſt, by reaſon of their ſtanding ſo high above the ſurface of the ground; ſo that on the whole, Mr Marſhal concludes, that the common white turnip is to be preferred to every other.

Advantage of uſing marl.

In Norfolk, turnips are ſown upon every ſpecies of arable land. Marl is found to be highly beneficial; and by means of this manure, a ſoil naturally unfit for turnips may be rendered proper for it. They ſucceed barley better than any other crop; ſome few are ſown on wheat or pea ſtubble after harveſt; but this is

Manures of different kinds.

not a general practice. The manures in greateſt reputation for turnips are dung, with a greater or ſmaller admixture of mould; *malt-coombs* are alſo in good repute, and oil-cake is uſed by a few individuals; “but it may be ſaid that nine acres of ten of the turnips grown in eaſt Norfolk are manured with muck.”—The quantity of dung ſet on for a crop of turnips generally depends on the quantity on hand, and the quantity of turnip ground to be manured. From 10 to 15 cart loads of muck are conſidered as a good dreſſing; and about a ton of oil-cake to three acres; 50 or 60 buſhels of malt-coombs, and 40 or 50 buſhels of ſoot, to an acre.

Cultivation of turnips for early conſumption.

When turnips are intended for early conſumption, the ſooner they can be got into the ground the better; but when they are intended to ſtand the winter, the beginning of July is thought ſoon enough. The moſt general rule is to begin ſowing about a week before midſummer, and continue till about a fortnight after, viz. from the 17th or 18th of June to the 7th or 8th of July.—Broad-caſt ſowing is univerſal, in the quantity of two pints to an acre. The ſeed is covered by two lines of a pair of light harrows drawn backward, in order to prevent the tines, which uſually point ſomething forward, from tearing up the clods, and burying the ſeed too deep. The horſes are univerſally *walked* one way, and *trotted* back again in the ſame place. This is an excellent cuſtom; the quick zig-zag motion of the harrows at once aſſiſting to level the ſurface, and to diſtribute the ſeeds more evenly.—They are univerſally hoed; and unleſs they be ſown very late, are generally hoed twice. The diſtance of time between the ſowing and the firſt hoeing depends upon the ſoil and

Method of ſowing, and culture.

and ſeaſon; the ſize of the plants being the only guide. When turnips are ſuffered to grow too large before they are hoed, the plants are difficult to be ſet out ſingly, and are liable to be drawn up by weeds, thereby acquiring a ſlender upright tendency; whereas their natural growth, in their infant ſtate, is procumbent, ſpreading their firſt leaves on the ground, and taking the form of a roſe.—If the hoe be put in too ſoon, the plants which are ſet out are liable to be buried, and their tender roots diſturbed in the act of ſetting out the neighbouring plants. The time for hoeing, as directed by the moſt judicious huſbandmen, is when the plants, as they lie ſpread upon the ground, are about the ſize of the palm of the hand: if, however, ſeed-weeds be numerous and luxuriant, they ought to be checked before the turnips arrive at that ſize, leſt being drawn up tall and ſlender they ſhould acquire a weak and ſickly habit. The proper diſtance depends upon the nature of the ſoil and the time of ſowing; ſuch as are ſown early, in a rich productive ſoil, require to be ſet out wider than thoſe ſown late on a ſoil of a contrary nature. If the ſoil be at par, the diſtance ought to be regulated by the time of ſowing: if this be at par, the nature or ſtate of the ſoil ſhould be the regulator.—Mr Marſhal complains of the conduct of the Norfolk farmers in general in this reſpect, who "hack out their turnips 14, 15, or perhaps 18 inches aſunder, without any regard to the ſtate of the ſoil, or time of ſowing. This practice was eſtabliſhed while the Norfolk ſoil was full of marl, and new to turnips; and when, it is probable, 11 or 12 inches in diameter was no uncommon ſize, with tops proportionally large and ſpreading; and 14 or 15 inches might then be a proper diſtance.

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But now, when the efficacy of marl is leſſened, and the ſoil no longer the favourite of turnips, which ſeldom reach more than ſeven or eight inches in diameter, it is ruinous and abſurd to continue the practice."

Cultivation of turnips for ſeed.

Turnips are cultivated either for ſeed, for ſale, or for conſumption. When cultivated for ſeed, it is ſuppoſed in moſt parts of the kingdom that it ought always to be taken from tranſplanted roots; but in Norfolk they are frequently raiſed from ſuch as are untranſplanted. "It is a fact (ſays Mr Marſhal) well underſtood by every huſbandman in Norfolk, that if the ſeed be gathered repeatedly from untranſplanted roots, the plants from this ſeed will become coarſe-necked and foul-rooted; and the fleſh of the root itſelf will become rigid and unpalatable. On the contrary, if it be gathered year after year from tranſplanted roots, the necks will become too fine, and the fibres too few; the entire plant acquiring a week delicate habit, and the produce, though ſweet, will be ſmall. For the neck, or onſet of the leaves, being reduced to the ſize of the finger (for inſtance), the number and ſize of the leaves will be reduced in proportion; and in a ſimilar proportion will the number and ſize of the fibrils be reduced. From a parity of reaſoning, it may perhaps be inferred; that when the neck acquires a thickneſs equal to that of the wriſt, the ſize of the root will be in proportion.

With reſpect to the fibres or rootlings, this is a juſt inference; but with reſpect to the bulb, it is in a great meaſure erroneous. For a few generations the ſize of the bulb will keep pace with the increaſe of leaves and fibres; but after having once reached the

limits

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limits which nature has ſet to its magnitude, it begins to revert to its original ſtate of wildneſs, from which to its preſent ſtate it has undoubtedly been raiſed by tranſplantation. The farmer has therefore two extremes to avoid. The one is diſcoverable by the thickneſs and coarſeneſs of the neck, the ſcaly roughneſs of the bulb, the thickneſs of the rind in general, the foulneſs of its bottom, and the forkedneſs of its main or tap root: the other by the ſlenderneſs of the neck, the fineneſs of the leaf, and the delicacy of the root. The former are unpalatable to cattle, and are therefore creative of waſte: The latter are unproductive, are difficult to be drawn, and do not throw out ſuch ample tops in the ſpring, as do thoſe which are, by conſtitution or habit, in a middle ſtate between theſe two extremes. There is not, however, any general rule reſpecting how many years turnips ought to be tranſplanted ſucceſſively, and how often they ought to be ſuffered to run up from the ſeed-bed: the ſoil and ſituation have, and other circumſtances may have, influence on the habit and conſtitution of vegetables as of animals; and the farmer muſt attend to the ſtate of the turnips themſelves. Whenever he judges, that, by repeated tranſplantation, they have paſſed the acme of perfection, then it is his duty and intereſt to let them run up to ſeed without tranſplantation. In Norfolk it has been found, by long experience, that tranſplanting two, three, or four years, and letting the plants run up the third, fourth, or fifth, will keep the ſtock in the deſired ſtate. The time of tranſplanting is from Old Chriſtmas to Old Candlemas. In the choice of plants, the farmer is not guided by ſize, but picks the cleaneſt plants without regard to ſize; or, more accurately ſpeaking, he makes choice of ſuch as are near, but not at or above, the ſtate of perfection. In almoſt every turnip-field there are plants in various ſtates: much judgment, therefore, is requiſite in the choice of plants. A piece of good ground near a habitation is generally choſen for this purpoſe; but the method of planting is various: the plants are generally ſet in rows, at uncertain diſtances from one another." Theſe diſtances the ſame author has obſerved to be 16 or 18 inches, and the diſtance of the plants in them nine or ten inches; but the practice of a man who, he tells us, is indiſputably near the head of his profeſſion, is to plant them in rows two feet aſunder, the plants in the rows being contiguous. The only culture required, is to keep the intervals clean hoed; but when the ſeed begins to ripen, much care is requiſite to keep it from birds. If the plot be large, it is neceſſary to employ a boy to ſcare them; but if it be ſmall, and near the houſe, Mr Marſhal has known the following expedient uſed with ſucceſs. "On a ſlender poſt, riſing in the midſt of the patch of ſeed, was fixed a bell; from which a line paſſed into the kitchen: in the moſt frequented part of this hung the pull. Whoever paſſed the pull rung the bell; ſo that in a farm-houſe kitchen, where a miſtreſs and two or three maids were ſome of them almoſt always on the foot, an inceſſant peal was kept up; and the birds, having no reſpite from alarm, forſook their prey."

Method of planting.

Method of ſcaring away birds.

Of drawing the turnips.

The time of drawing commences about Michaelmas, and continues until the plants be in blow. The proceſs of drawing, he ſays, "in ſevere weather is an employment which nothing but cuſtom could reconcile to thoſe whoſe lot it is to go through it, namely, ſtout lads and youths; whoſe hands are frequently ſwelled until the joints are diſcernible only by the dimples they form;" nevertheleſs he never heard of any inſtance of bad effects from this circumſtance. When the tops will bear it, their method of pulling is very expeditious: they pull with both hands at once; and having filled each hand, they bring the two together with a ſmart blow to diſengage the ſoil from the roots, and with the ſame motion throw them into the cart. If the tops be cut off by the froſt, or if this be in the ground, the turnips are raiſed with two-tined forks named *crooms*. If the roots are buried under deep ſnow, it is removed by means of an implement called the *ſnow-ſledge*. This conſiſts of three deal-boards from one to two inches thick, 10 or 12 inches deep, and from ſeven to nine feet long, ſet upon their edges in the form of an equilateral triangle, and ſtrongly united with nails or ſtraps of iron at the angles; at one of which is faſtened, by means of a double ſtrap, a hook or an eye, to faſten the horſes to. This being drawn over a piece of turnips covered with ſnow, forces up the latter into a ridge on each ſide, while between the ridges a ſtripe of turnips is left bare, without having received any material injury from the operation. Though it is cuſtomary, in drawing, to clear the ground entirely, our author met with one inſtance in which the ſmall ones were left by a very good huſbandman on the ground, both to increaſe in ſize, and to throw out tops in the ſpring; it being obſervable, that a ſmall turnip ſends up a top nearly equal to one whoſe bulb is larger. There is one inconvenience, however, ariſing from this practice: the plough is prevented from entering upon the ſoil until late in the ſpring; which

Snow-ſledge deſcribed.

upon ſome ſoils is an unſurmountable objection; though it may be very proper upon land which will bring good barley with one ploughing after turnips.

Mr Marſhal relates the following ſimple method, by which a Norfolk farmer preſerved turnips through a conſiderable part of the winter ſeaſon. Having cut off their tops with a ſpade, he gave them to his cows, and carried the bulbs to a new-made ditch, into which he threw them, and then covered them up with ſtraw, laying over it a quantity of bramble kids. Here they lay until wanted in a froſt. They were then again carted by means of a fork, and given to the cattle, who ate them as well, or rather better than freſh-drawn turnips; and in general they came out as freſh as they went in. Our author is of opinion, that this method might be extended to the preſervation of turnips till the ſpring.

END OF VOLUME FIRST.

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Plate I.

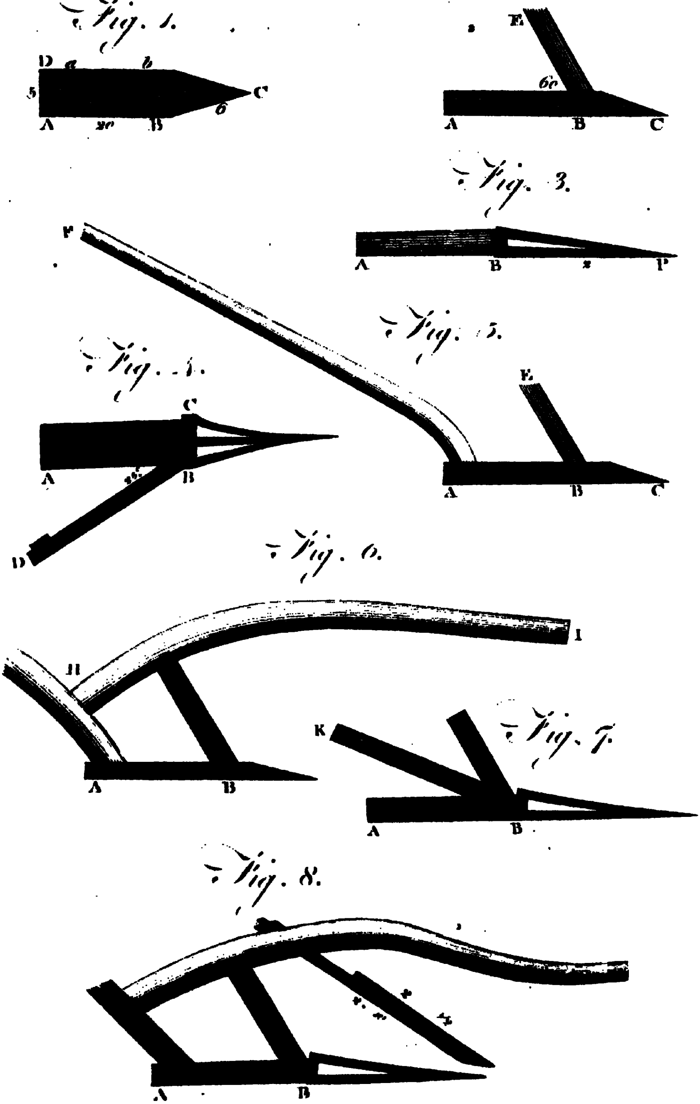
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
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Fig. 6.
Fig. 7.
Fig. 8.

Plate II.

Fig. 1.

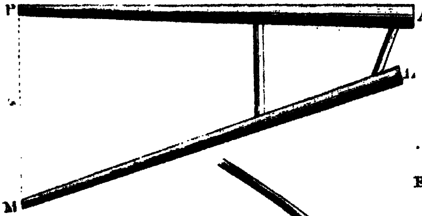
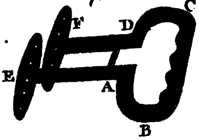


Fig. 2.



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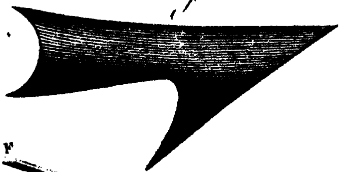


Fig. 4.

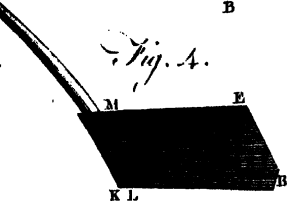


Fig. 5.

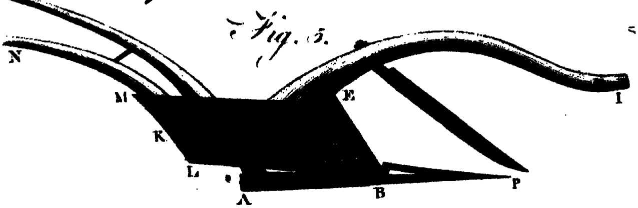
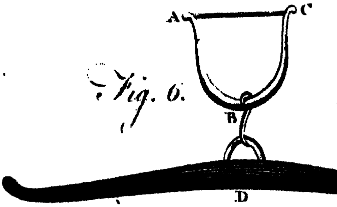


Fig. 6.



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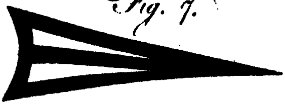

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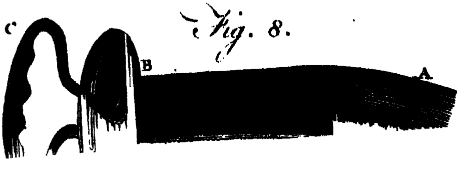

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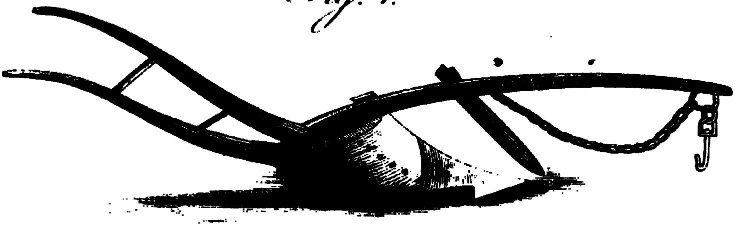

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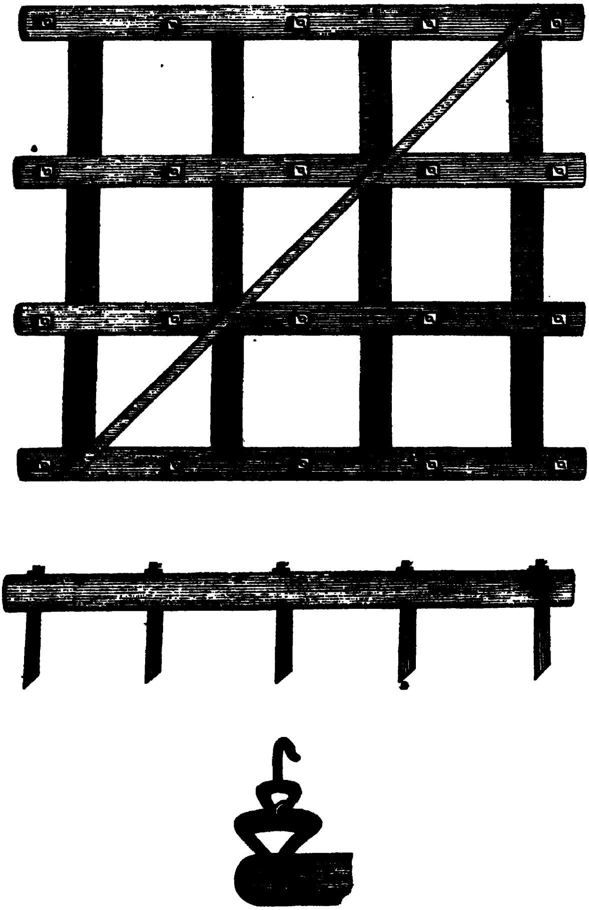

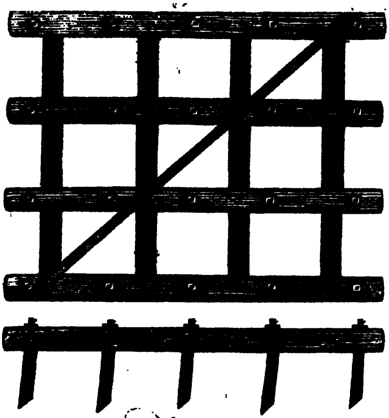

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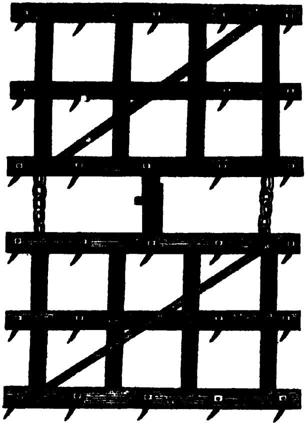

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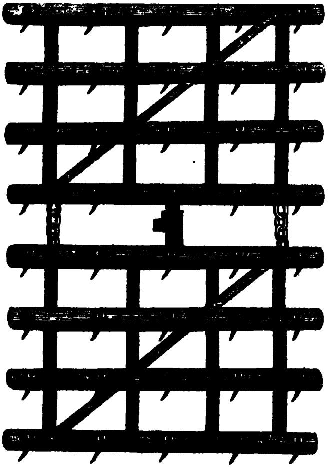

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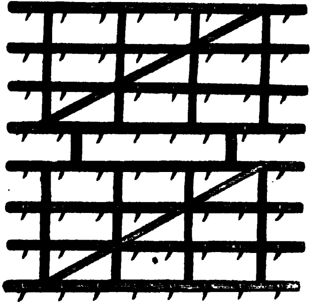

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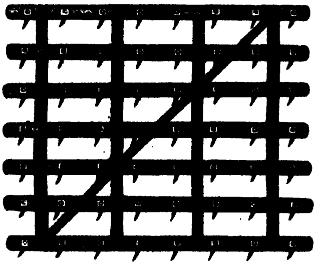

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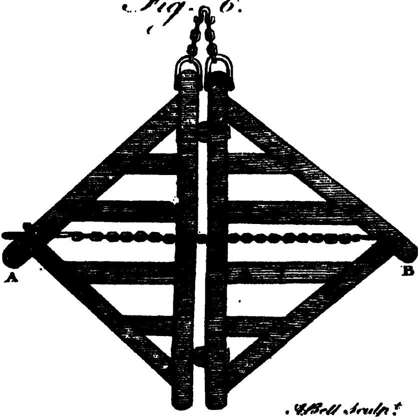
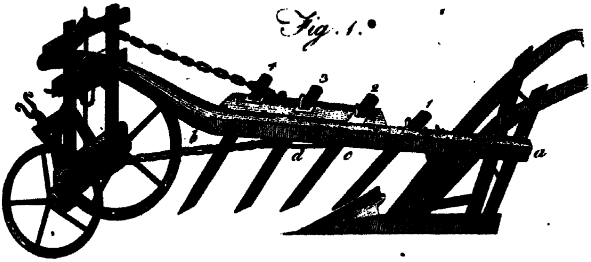


A. Bell Sculpt.

Plate

Fig. 1.



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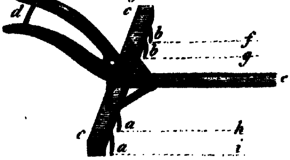

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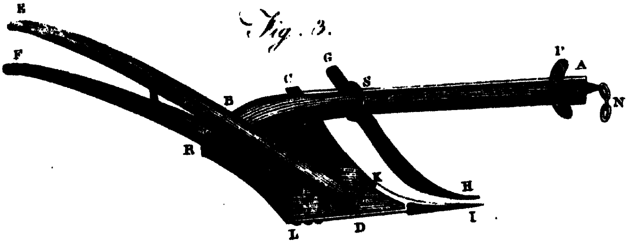

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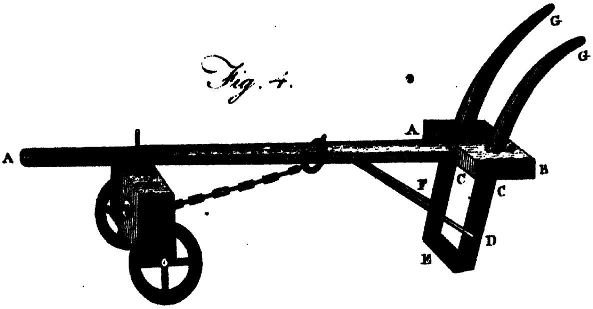
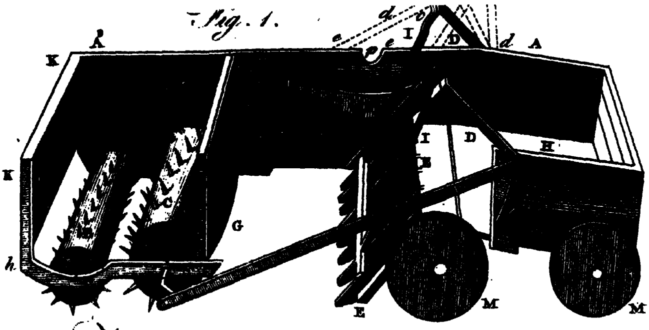


Fig. 1.



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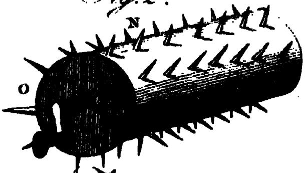

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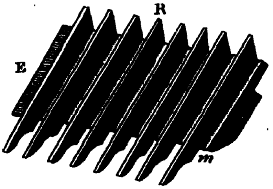

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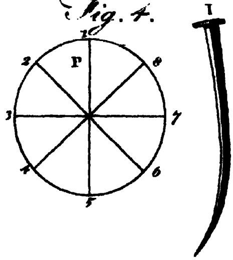

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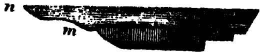

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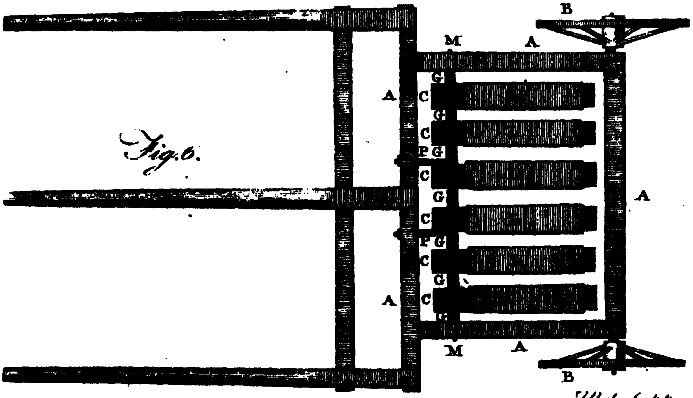
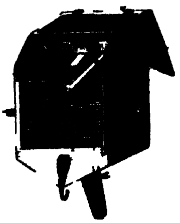
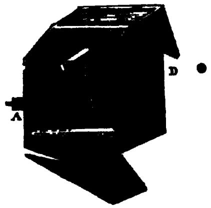


J.Neil Sculpt





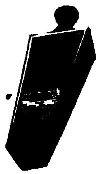
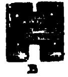


Fig 4



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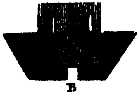

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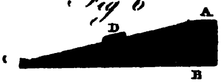

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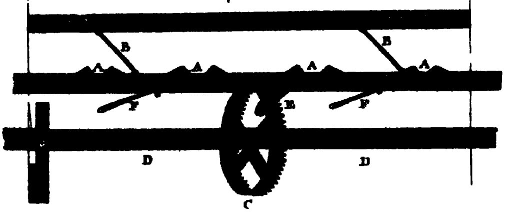

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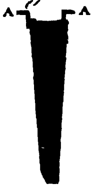

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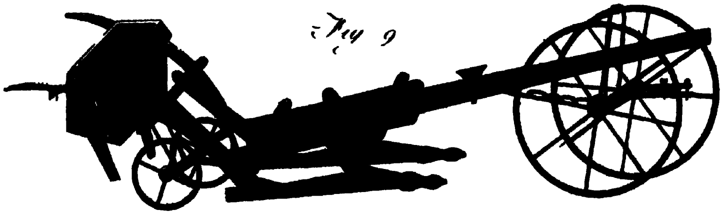

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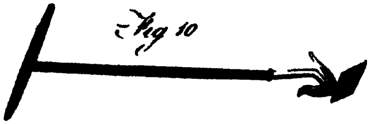
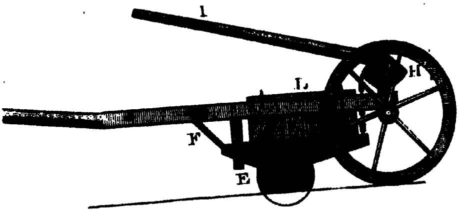


I Hall Sculp



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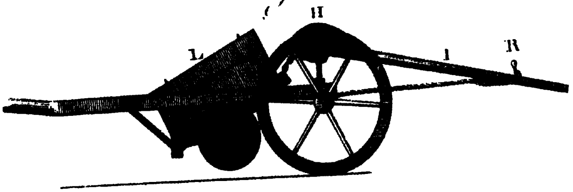

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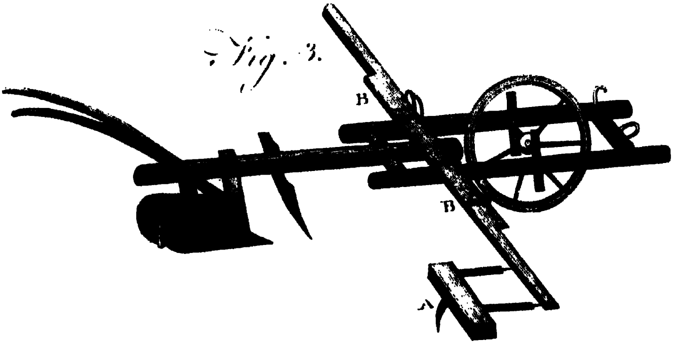

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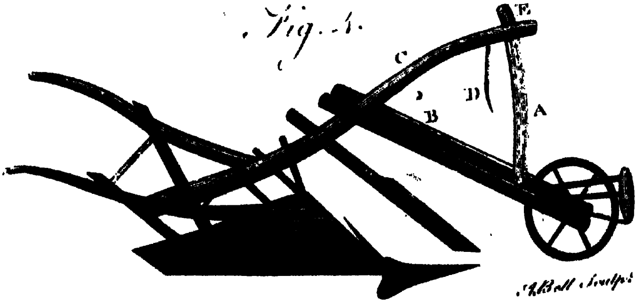
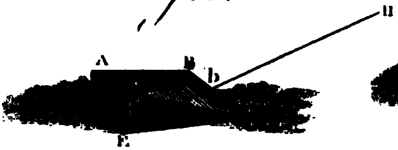


A. Bell Sculpt.

Fig. 1.



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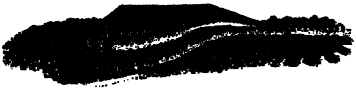

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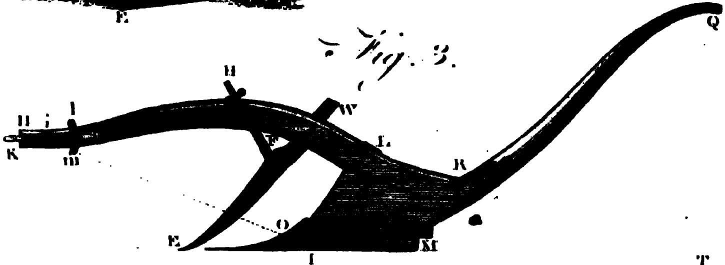

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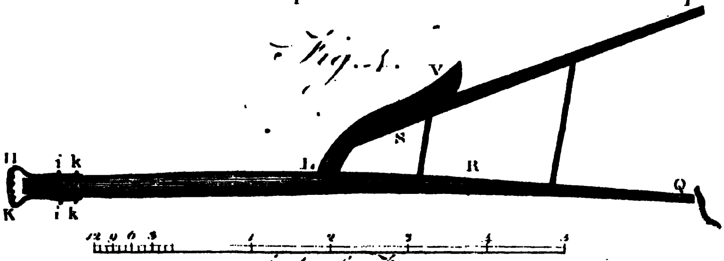
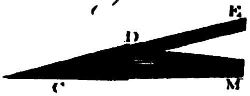


Scale of Feet.

Fig. 5.



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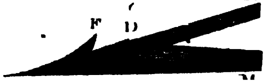

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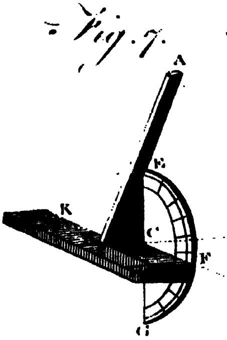

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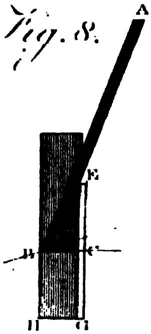


A. Bell sculp.

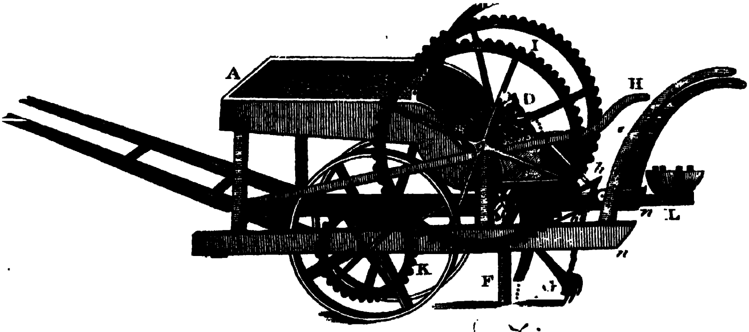


Fig. 2.

Fig. 3.

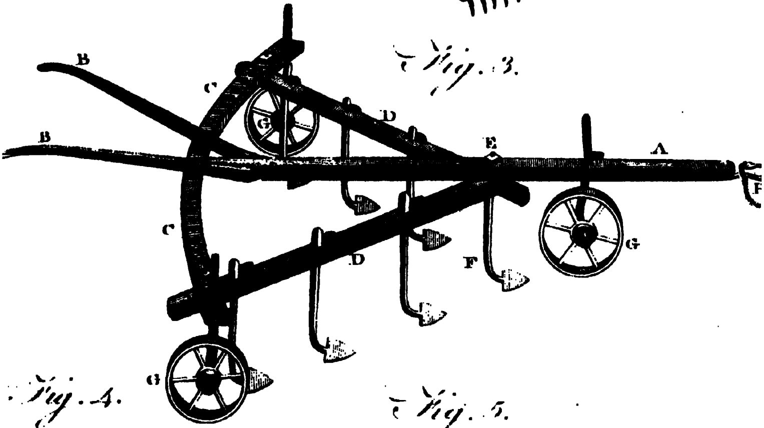
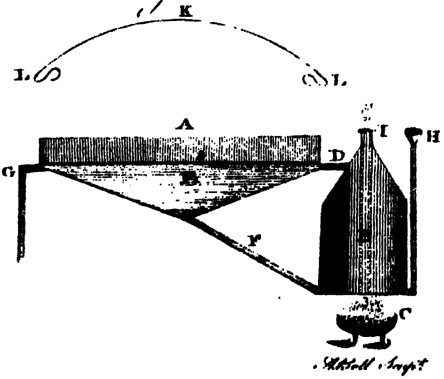
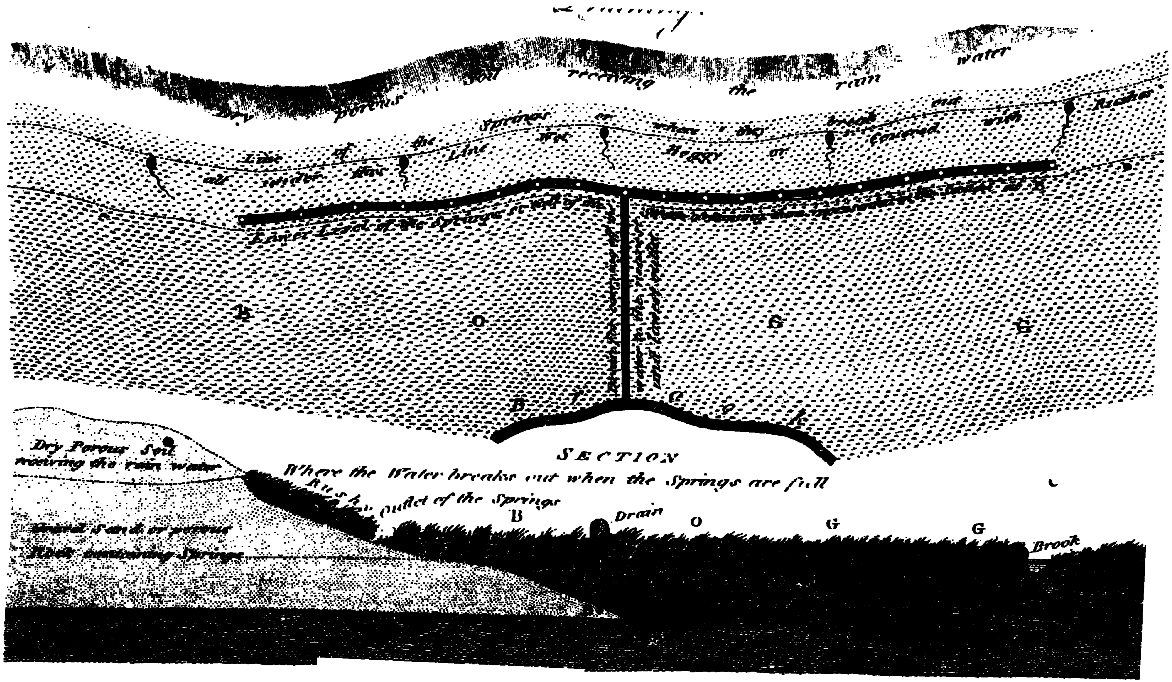


Fig. 4.

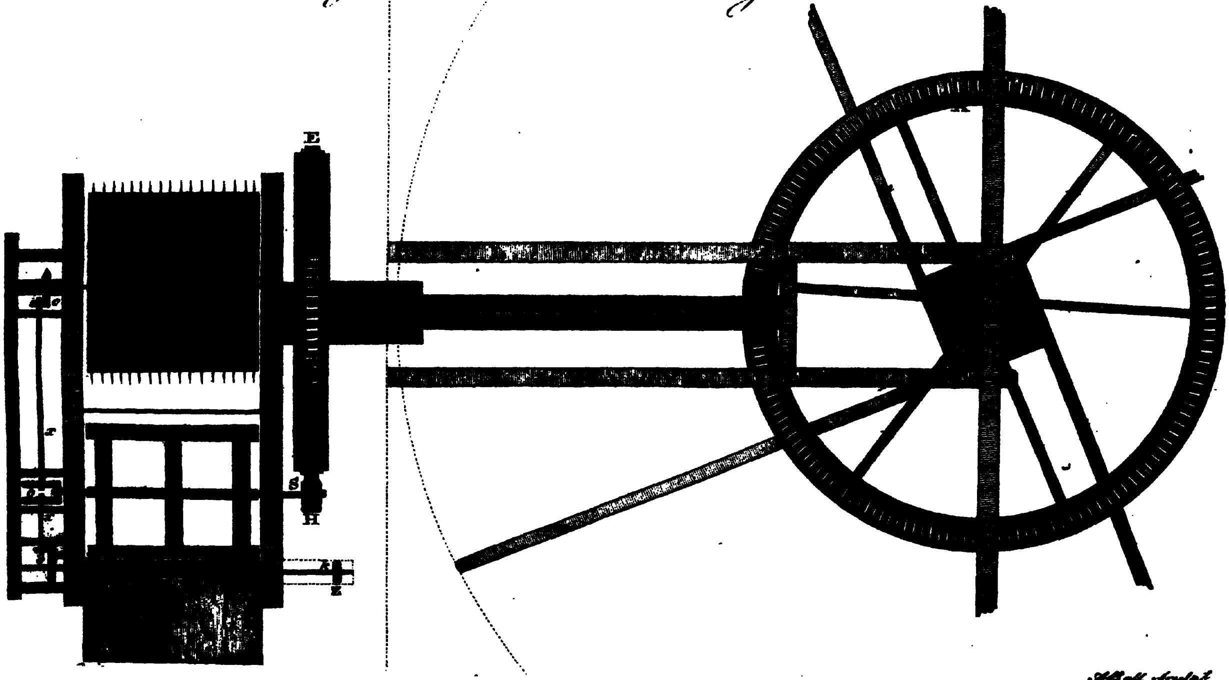
Fig. 5.



A. Bell Sculp.t


Dry porous Soil receiving the rain water
Line of the Springs or where they break out
all under this Line Wet Boggy or Covered with Rushes
Lower Level of the Springs
Drain for conveying the
water to the nearest and lowest outlet
B
O
G
G
B
C
SECTION
Where the Water breaks out when the Springs are full
Rushy outlet of the Springs
Dry Porous Soil receiving the rain water
Gravel Sand or porous Rock containing Springs
B
Drain
O
G
G
Brook
S.Bell

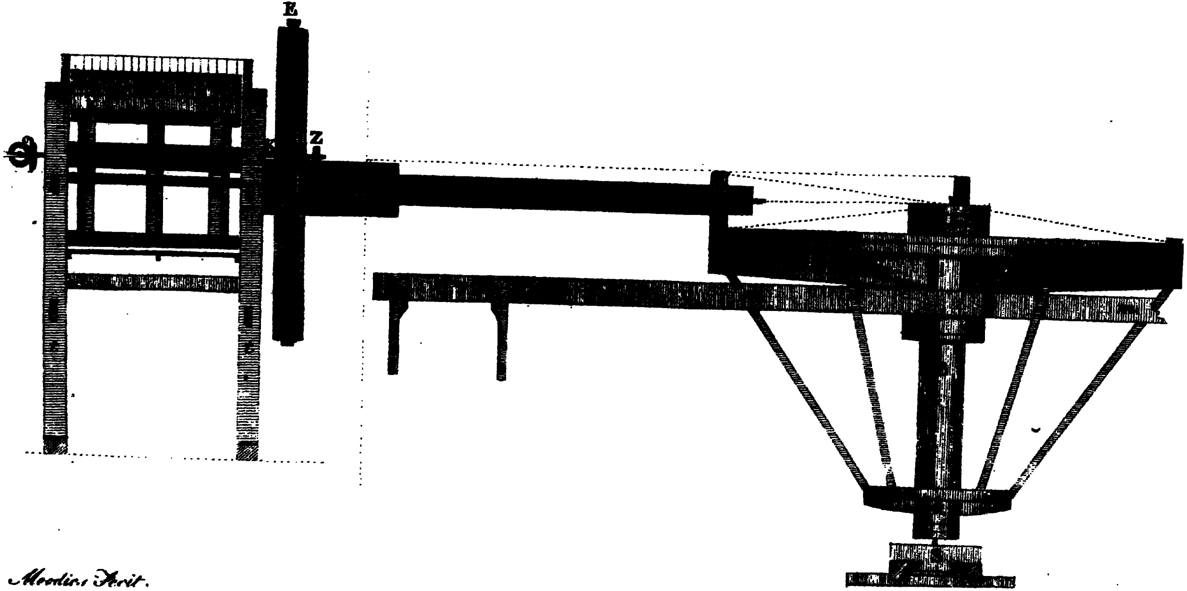
No. 1 Ground Plan of the Threshing Machine.



A. Bell Sculpt.

Elavation of the Threshing Machine

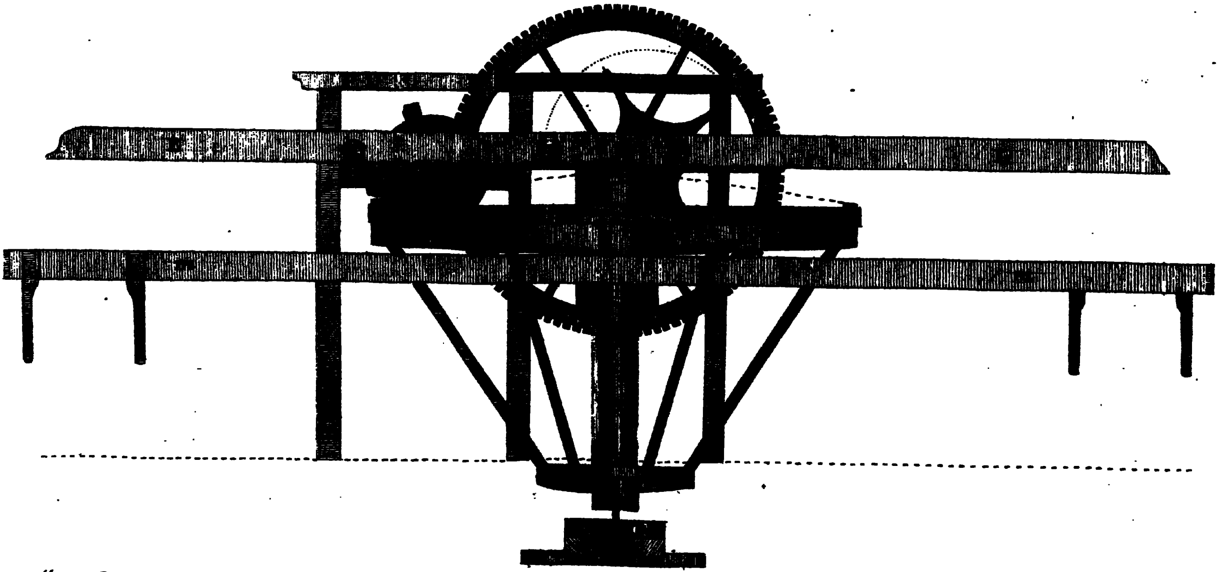
Plate XVII.



Moodie, Fecit.

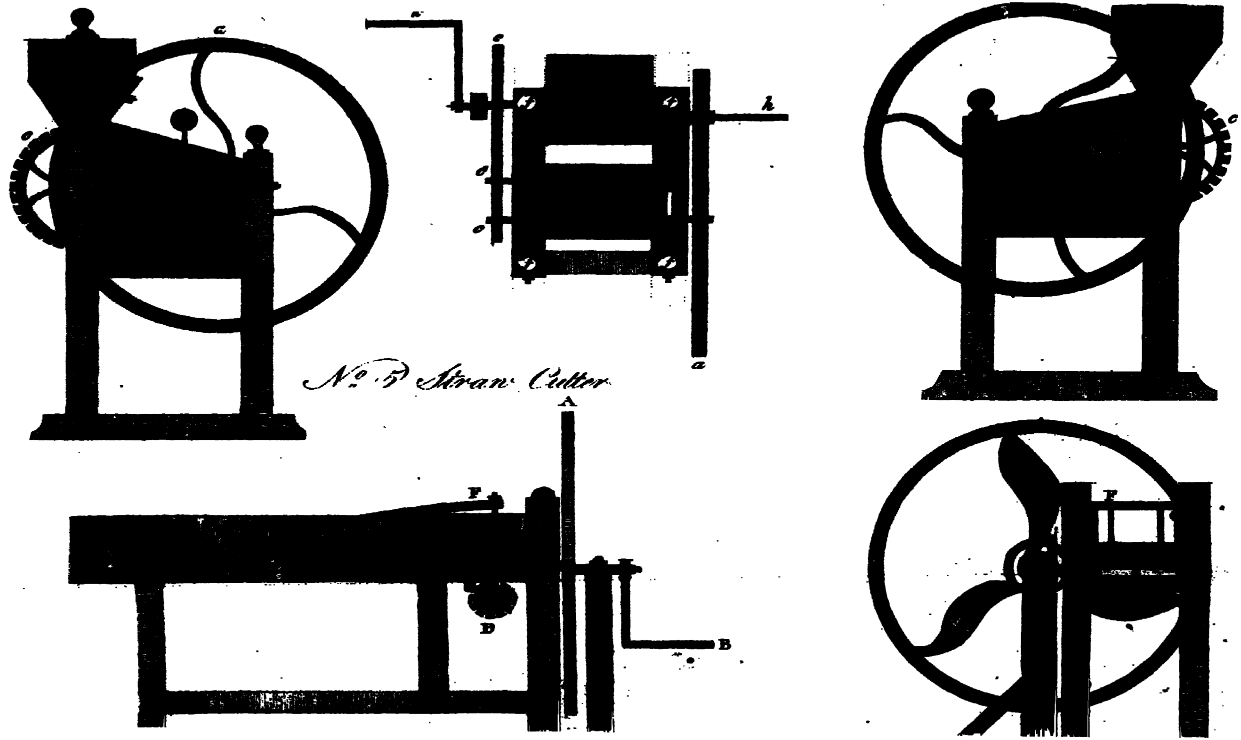
A Bell Sculp.^t

N.º 3 End View of the Threshing Machine Plate XV



Menzies Fecit

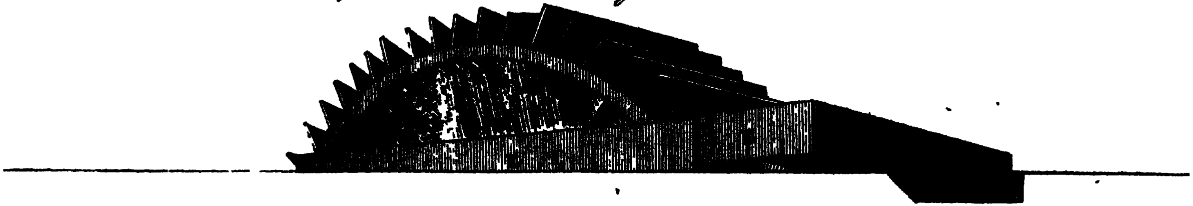
A Bell Sculp



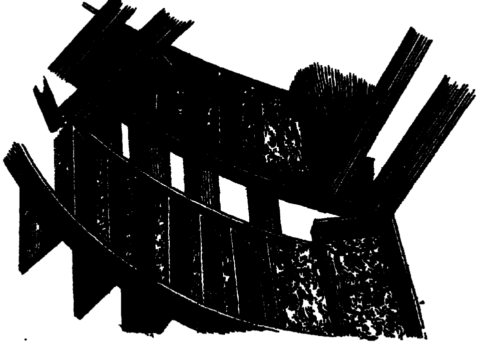
Nº. 5 Straw Cutter

Plate XXI.

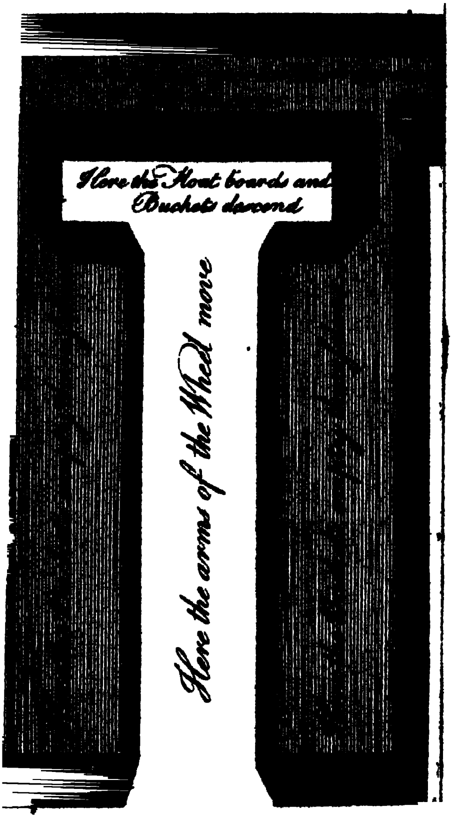
Sketch of the Wheel for raising Water at Blair Drummond



Sketch of the manner in which the Water is filled from the Troughs into the Buckets



A. Bell Sculp.t


Here the Float boards and Buckets descend
Here the arms of the Wheel move